
Chorlton High School South (CHSS)

Acoustic Design Strategy Report – Stage 4

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1 Introduction

This report outlines the acoustic design strategy for the proposed Chorlton High School South development and includes the following:

- Proposed acoustic design criteria;
- Summary of environmental noise surveys & noise prediction modelling undertaken;
- Acoustic design strategy, including ventilation strategy, airborne sound insulation, impact sound insulation, control of reverberation and the control of noise from building services;
- Outline measures to protect the amenity of nearby noise sensitive receptors.

2 Design Guidance

The proposed acoustic requirements are provided on the basis of the project Brief documents, relevant British Standards, Codes of Practices & best practice professional guidance publications, and Local Authority requirements. The most relevant guidance referenced when developing the criteria is Building Bulletin 93.

2.1 Building Bulletin 93 ‘Acoustic Design of Schools’, 2015 (BB93)

Acoustic conditions in educational buildings are controlled by Part E of the Building Regulations, Schools Premises Regulations and the Independent School Standards. Premises are also subject to the Equality Act.

Requirement E4 of the Building Regulations applies to teaching and learning spaces and states *‘each room or other space in a school building shall be designed and constructed in such a way that it has the acoustic conditions and the insulation against disturbance by noise appropriate to its use.’*.

The normal way of satisfying Requirement E4 of the Building Regulations, School Premises Regulations and Independent School Standards is to meet the values for sound insulation, reverberation time and internal ambient noise level given in BB93 ‘Acoustic Design of Schools: Performance Standards’.

2.2 Other relevant guidance

Other relevant guidance documents referenced when developing the acoustic criteria include:

- British Standard 4142: 2014 (BS 4142) ‘Method for rating and assessing industrial and commercial sound’.
- Manchester City Council ‘Planning & Noise Technical Guidance’, 2015
- Sports England Artificial Grass Pitch (AGP) Acoustics - Planning Implications 2015

It is understood that an ‘unofficial’ BREEAM Very Good appraisal may be required as part of the planning process. The acoustic strategy will support this appraisal; BREEAM refers to the BB93 performance standards on which the acoustic strategy is based.

3 Proposed Criteria

The acoustic design criteria are proposed on the basis of the BB93 performance requirements. In accordance with BB93, where criteria are specified for ancillary spaces (i.e. non-teaching/learning) these are provided for guidance only.

3.1 Internal Ambient Noise Levels (IANL)

The IANL criteria are proposed in accordance with BB93 guidance.

The IANL includes noise contributions from:

- External sources outside the building premises (including, but not limited to, noise from road, rail and air traffic, industrial and commercial premises).
- Building services (e.g. ventilation systems, plant, drainage).
- Actuator and damper noise.

The IANL excludes contributions from:

- Activity noise within the building premises (e.g. noise from staff, students and equipment within the building).
- Rain noise - however lightweight roofs and any roof glazing should be designed to provide suitable control of rain noise reverberant sound pressure level in a space.
- Emergency plant such as electrical generators.

A summary of the proposed IANL criteria is provided in the table below for the main room types within Chorlton High School South.

Table 1: BB93 Internal ambient noise level criteria

Room Type	IANL upper limit, dB L _{Aeq,T}
General Classrooms, Music Classrooms & Practice rooms	35
Offices, Staff workrooms, Meeting rooms, Interview room	40
SEN Group Rooms	30
SEN Therapy	35
Kitchen	50
Science Labs, RM workshops, Food, Art, ICT, Textiles, Graphics, Libraries & resource/breakout areas	40
Main Hall, Drama	35
Sports Hall, Activity Studio	40
Control room	35
Circulation spaces, corridors, stairwells	45
Toilets	50
Changing Rooms	50

Room Type	IANL upper limit, dB L _{Aeq,T}
Dining Room	45

3.1.1 Building services and indoor ambient noise levels

The IANL criteria in teaching and learning spaces should be achieved when the ventilation systems are operating in their normal condition; when providing intermittent boost ventilation; and when operating to control summertime overheating (as defined in BB93). A ventilation strategy may use one type of system for normal operation, and different types of system for intermittent boost and summertime overheating. The tolerances on the IANL limits applicable to the project are defined in Table 2 of BB93 for different types of ventilation system under different operating conditions (refer Appendix II). For example, for typical teaching spaces under ‘normal operation’ a +5dB relaxation to the IANL is allowed where natural ventilation is provided. Where hybrid/mixed mode ventilation is provided a +5dB relaxation is allowed to the overall IANL, although no relaxation is allowed to the mechanical noise component.

3.2 Rain Noise

Rain impact noise should not result in undue disturbance in internal spaces. Indoor ambient noise levels during ‘heavy’ rainfall (as defined in BS EN ISO 140-18) should not exceed the stated IANL criteria by more than 25 dB(A).

3.3 Airborne Sound Insulation

The sound insulation is assessed in terms of standardised level difference D_{nT} in accordance with BS EN ISO 16283-1 and the results are weighted and expressed as a single-number quantity, D_{nT,w} in accordance with BS EN ISO 717-1. For the purposes of the assessment, the reference reverberation time T may be either:

- the upper limit for the mid-frequency reverberation time, T_{mf,max} for the receiving room type (see Table 5) applied to all one-third octave bands from 100 Hz to 3.15 kHz;

Or, for commissioning measurements:

- the measured reverberation time in each one third octave band, provided that the mid-frequency reverberation time, T_{mf}, complies with the requirements in Table 5 and is representative of the reverberation times expected when the room is finished and unfurnished.

Table 3 presents the proposed minimum standards for airborne sound insulation required between rooms. These values are defined by the activity noise in the source room and the noise tolerance in the receiving room as given in Table 2. The design assessment of D_{nT,w} between two rooms should be carried out in both directions.

Table 2: Proposed room classification for sound insulation requirements

Room Type	Noise Generation (Source Room)	Noise Tolerance (Receiving Room)
General Classrooms	Average	Medium
Music Classrooms & Practice rooms	Very High	Low
Offices, Staff workrooms, Meeting rooms, Interview room	Low	Medium
SEN Resource, Group Rooms	Average	Medium
SEN Therapy	Low	Medium
Kitchen	High	High
Science Labs, Food, Art, ICT, Textiles, Graphics, Libraries & resource/breakout areas	Average	Medium
RM workshops	High	High
Main Hall, Drama	High	Low
Sports Hall, Activity Studio	High	Medium
Control room	Average	Medium
Circulation spaces	Average	Medium
Corridors, stairwells	Average	High
Toilets, Changing Rooms	Average	High
Dining Room	High	High

Table 3: BB93 performance standards for airborne sound insulation between spaces

Minimum $D_{nT,w}$ (dB)		Activity noise in source room			
		Low	Average	High	Very High
Noise tolerance in receiving room	High	N/A	35	45	50
	Medium	40	45	50	55
	Low	45	50	55	55

The following additional airborne sound insulation criteria clarifications should be noted:

The airborne sound insulation criteria proposed in the tables above does not apply where a noise sensitive room is linked with another occupied room via an interconnecting door for operational or safety purposes. Where this occurs, a doorset should be used with a rating of at least R_w 35 dB. The surrounding wall (including any glazing) should have a composite sound insulation rating of at least R_w 45 dB.

The airborne sound insulation criteria proposed in the tables above does not apply where a moveable wall is present between adjacent spaces. Where a moveable wall is present between a teaching or learning space and an adjacent space, the D_{nT,w} between the spaces should be at least 40 dB.

BB93 Sound insulation requirements for meeting rooms only achieve a basic level of acoustic privacy as defined in BS8233.

3.3.1 Airborne sound insulation between circulation spaces and adjacent rooms

The objective is to attenuate airborne sound transmitted between dedicated circulation spaces and other spaces used by students, for the purpose of minimising disturbance to teaching and learning spaces. This applies where the separating construction contains doors and/or glazed elements.

The following table presents the proposed minimum permissible airborne sound insulation for a separating corridor wall that contains doors and/or glazed elements.

Table 4: BB93 performance standards for airborne sound insulation between dedicated circulation spaces and adjacent spaces separated by a wall containing a door and/or glazing

Type of space	Minimum R_w dB		Minimum $D_{n,e,w}$ - 10LgN dB for transfer grilles, where N is the number of grilles
	Composite R_w of wall and glazing with no ventilator	Doorset	
Music Classrooms, Practice Rooms, Main Hall, Drama, SEN rooms	45	35	37
All other rooms used for teaching or learning	40	30	32

3.4 Impact Sound Insulation of floors

The objective is to control impact sound (eg from footsteps and movement of furniture) transmitted into spaces via the floor above.

It is proposed to base the impact sound insulation criteria on BB93 2015 requirements.

Table 4 presents the proposed impact sound insulation performance criteria. Values in the table are the maximum permissible weighted standardised impact sound pressure level $L'_{nT,w}$ dB. This is measured in accordance with BS EN ISO 140-7 and rated in accordance with BS EN ISO 717-2.

For the purposes of the assessment the reference reverberation time T may be either:

- the upper limit for the mid-frequency reverberation time, $T_{mf,max}$ for the receiving room type (see Table 5) applied to all one-third octave bands from 100 Hz to 3.15 kHz;

or, for commissioning measurements:

- the measured reverberation time in each third octave band, provided that the mid-frequency reverberation time, T_{mf} , complies with the requirements in Table

5 and is representative of the reverberation times expected when the room is finished and unfurnished.

The impact sound insulation performance requirements do not apply where the upper room is normally unoccupied (e.g. store rooms and plant rooms).

Table 4: BB93 performance standards for impact sound insulation of floors

Type of room (receiving room)	Maximum impact sound pressure level $L'_{nT,w}$
General Classrooms	60
Music Classrooms & Practice rooms	55
Offices, Staff workrooms	65
Meeting rooms, Interview room	60
SEN Group Rooms	55
SEN Therapy	60
Kitchen	65
Food, Art, ICT, Textiles, Graphics, Libraries & resource/breakout areas, RM workshops	60
Main Hall, Drama	60
Dining Room	65

3.5 Room Acoustics

The objective is to provide suitable reverberation times (RTs) for:

- Clear communication of speech between teacher and student;
- Clear communication between students.

The proposed reverberation time criteria is presented in the following table. The reverberation time is quoted in terms of the mid-frequency reverberation time, T_{mf} which is the arithmetic average of the reverberation times in the 500 Hz, 1 kHz and 2 kHz octave bands, or the arithmetic average of the reverberation times in the one-third octave bands from 400 Hz to 2.5 kHz. These values are for rooms that are finished, furnished for normal use, but unoccupied.

Table 5: BB93 performance standards for reverberation time

Type of room (receiving room)	T_{mf} seconds
General Classrooms	≤ 0.8
Music Classrooms	≤ 1.0
Music Practice rooms	≤ 0.6
Ext Music Practice	≤ 0.8
Offices, Staff workrooms	≤ 1.0
Meeting rooms, Interview room	≤ 0.8
SEN Therapy, Group rooms (SEN)	$\leq 0.4^1$
Kitchen	≤ 1.5
Science Labs, Food, Art, ICT, Textiles, Graphics	≤ 0.8

Type of room (receiving room)	T_{mf} seconds
Libraries	≤ 1.0
Resource/breakout areas	≤ 1.2
RM workshops	≤ 0.8
Main Hall	$0.8 - 1.2^2$
Control room	≤ 0.8
Drama	≤ 1.0
Sports Hall	$\leq 2.0^3$
Activity Studio	≤ 1.5
Corridors, circulation, stairwells	ADE: refer Section 3.5.2
Toilets, Changing Rooms	≤ 1.5
Dining Room	≤ 1.0

¹ For this room type, $T < 0.4$ averaged from 125Hz – 4kHz octave band centre frequencies and $T < 0.6s$ in every octave band in this range.

² Reverberation time should be within the indicated range, including the values given.

³ Refer Section 3.5.1

3.5.1 Sports Hall & Activity Studio

In accordance with BB93, compliance with the reverberation time criteria for the Sports Hall and Activity studio will be demonstrated by execution of a design in accordance with the ‘Acoustics of Schools: a Design Guide’.

3.5.2 Sound absorption in enclosed corridors and stairwells which provide direct access to teaching and study spaces

The objective is to absorb sound in corridors and stairwells so that it does not interfere with teaching and study activities in adjacent rooms. This requirement applies to any corridor and stairwell which provides direct access to teaching and study spaces. The amount of absorption required should be calculated according to Approved Document E, Section 7. This describes two calculation methods, A and B, for controlling reverberation in the common internal parts of domestic buildings. Either of these methods can be used to determine the amount of absorption in corridors and stairwells.

3.6 External Noise Emission Criteria

3.6.1 Plant noise limits at nearest existing noise sensitive receptors

Preliminary advice has been sought from Manchester City Council in regards to suitable noise level criteria and assessment methodology for the proposed plant installation, with agreement on the proposed provided by Sharon McAndrew of MCC.

Within Manchester City Council’s ‘Planning & Noise – Technical Guidance (December 2015)’ document, it is stated that the following criteria be met in relation to noise and vibration from fixed plant / equipment:

‘Any noise assessment needs to consider not only the overall level of noise emitted but also its particular characteristics. The noise assessment should be based on BS 4142: 2014 and any application for fixed plant, equipment or machinery must demonstrate that:

Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location.’

It is worth noting that the above criteria corresponds with BREEAM Pol 05 (NC 2018) requirements.

3.6.2 Plant noise limits at the facades of the new CHSS building

When determining attenuation requirements in relation to external noise limits for fixed plant, it should be noted that plant must also be selected and/or designed to ensure that the external noise emissions generated at the facades/roof of the proposed development will not cause the proposed internal noise level criteria to be exceeded.

3.6.3 Sports pitch noise limits at nearest existing noise sensitive receptors

As agreed with the LPA, criteria for noise egress from the proposed football pitch has been based on Sports England guidance as detailed below.

In the guidance document ‘*Sports England Artificial Grass Pitch (AGP) Acoustics - Planning Implications 2015*’, Sports England discuss the analysis of sports noise from a typical artificial grass pitch (AGP) so not to disturb nearby existing residents.

The guidance does not state any definitive criteria but instead cites the World Health Organisation (WHO) ‘*Guidelines for Community Noise*’ (1999) which states:

“...the noise level outside a residential property during the daytime about 1 metre from façades of living spaces should not exceed 50 dB L_{Aeq} .”

The Sports England guidance goes on to state an alternative assessment methodology may be appropriate in some circumstances, such as when existing noise levels in the area are high. For example, it suggests that in some circumstances it would be appropriate to conclude that an increase in the ambient noise climate ($L_{Aeq, 1 \text{ hour}}$) of less than 3 decibels would result in a “slight impact”, and that this assessment conclusion *“generally conforms with the withdrawn Planning Policy Guidance Document 24 statement that a change of 3 dB(A) is the minimum perceptible under normal conditions.”*

The guidance goes on to state that:

“Where noise from the new source (the AGP) does not exceed the existing noise climate the increase in noise will be no more than 3 decibels. This is the minimum

that can normally be perceived. The noise levels are both to be measured using the L_{Aeq} parameter over the same time period, T .”

The following criteria has been proposed for the sports pitch based on the above AGP guidance:

- Where the measured pre-development ambient noise level (dB $L_{Aeq,T}$) at the nearest noise sensitive receptor is below 50 dB, the noise level resulting from noise from the proposed football pitch (dB $L_{Aeq, 1 \text{ hour}}$) should not exceed a level of 50dB at the receptor, as per WHO guidelines.
- Where the measured pre-development ambient noise level (dB $L_{Aeq, 1 \text{ hour}}$) at the nearest noise sensitive receptor is greater than 50 dB, the noise level resulting from noise from the proposed football pitch (dB $L_{Aeq, 1 \text{ hour}}$) should not exceed the measured pre-development ambient noise level at the receptor.

3.7 Room assignment clarification

As outlined in the ITT report, for the purposes of assessment the proposed SEN accommodation within the CHSS scheme (group rooms, therapy room) have been assigned BB93 room type classifications in accordance with the SOA issued to the design team during the ITT stage. Should the room assignments be revised resulting in more onerous criteria, the proposed acoustic design strategy in these areas would need to be reviewed; it would be anticipated that separating elements would need to be enhanced.

4 Environmental Noise Survey

An environmental noise survey has been undertaken on the 29th May 2019 at various positions on and in the vicinity of the proposed site. The data obtained has been used in order to assist in the following:

- Establishing the baseline noise climate at the site;
- Assessment of the required sound insulation of the building fabric, including glazing and ventilation; and
- Establishing noise limit criteria for external plant noise emissions associated with the project.

4.1 Survey Methodology

A series of manned short-term measurements were undertaken during ‘worst-case’ daytime and night-time periods. The approximate measurement positions are presented in the following figure and were selected in order to:

- Measure worst-case, i.e. noisiest, daytime (0800 – 1000 hours) noise levels in order to inform a 3D noise model of the site used to establish the required sound insulation of the building fabric, including glazing and ventilation (Positions 1 – 2);
- Provide data representative of the worst-case, i.e. quietest, daytime (1000 – 1100 hours) noise levels at the nearest or most exposed residential noise sensitive receptors for the purposes of informing environmental plant noise limits to maintain residential amenity (Positions 3 – 4).

Weather conditions during the survey were dry with low wind speeds (<2m/s), temperatures varying around 12°C and cloud cover of approximately 90%.

The instrumentation used for measurements consisted of 1no. Rion NA-28 sound level meter which was calibrated prior to commencing and upon completion of the survey, with no significant drift in sensitivity observed.

At each position octave band and A-weighted fast response levels were recorded for a comprehensive suite of noise level metrics. All readings were taken at a height of 1.5m above local ground level in free-field conditions. Measurements were carried out by Dan Forbes AMIOA.

Figure 1: Approximate survey measurement positions



4.1.1 On-Site Noise Climate

The ambient noise climate at the site is dominated by two main noise sources, road traffic noise from vehicles on Mauldeth Road West and, when present, noise from trams travelling along the tramline adjacent to the south of the site.

The background noise climate at the site is dominated by distant road traffic noise. Other noise sources contributing to the ambient noise climate on site include: noise from passers-by walking and talking; dogs barking within the Greater Manchester Police facilities adjacent to the north-west of the site; and airplanes passing overhead.

4.1.2 Results

A summary of the measured results are presented in Table 6 table below.

Table 6: Summary of noise measurement results

Measurement Position	Start Time (hh:mm)	L _{Aeq,5mins} Range (dB)	L _{AFmax,5mins} Range (dB)	L _{A90,5mins} Range (dB)
1	08:15	68 - 70	80 - 83	51 - 54
1	09:08	67 - 68	79 - 82	48 - 50
2	08:41	54 - 64	71 - 81	44 - 45
2	09:32	55 - 62	74 - 82	45 - 46
3	10:26	54 - 55	62 - 67	50
4	10:45	62 - 63	78 - 79	46 - 47

In addition to the survey data obtained, supplementary noise data collected as part of the site feasibility studies (by Encon Associates) has also been referenced where relevant to inform the acoustic assessments of the scheme.

5 Site Analysis

5.1 Noise Prediction Modelling

5.1.1 Predicted façade noise levels

3D noise prediction models have been created to establish predicted façade noise levels for the worst-case daytime periods.

A baseline model has been developed to enable validation of the model to the environmental noise survey data collected, accounting for the main sources of noise on-site (i.e. transport noise). A further model has then been developed, based on the current proposed layout for the site to predict the levels incident upon the development.

The following figures present the predicted noise contours across the proposed site.at 1.5m AGL caused by dominant traffic noise sources. Noise levels at the façades of the proposed buildings are predicted to range between 45 – 65 dBA.

Figure 2: Noise modelling screen shot presenting indicative dBA noise contour at 1.5m AGL

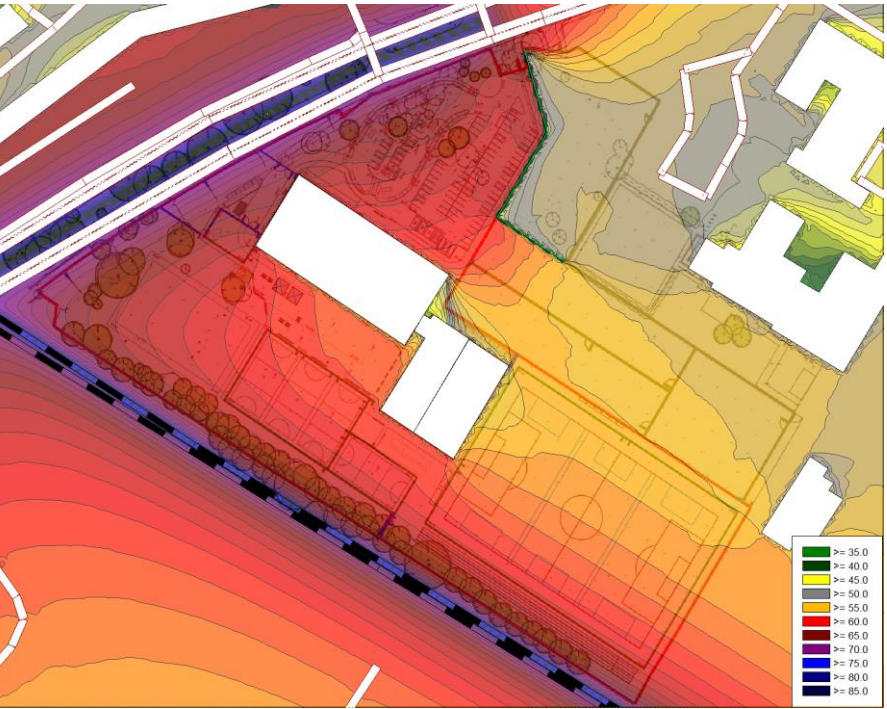
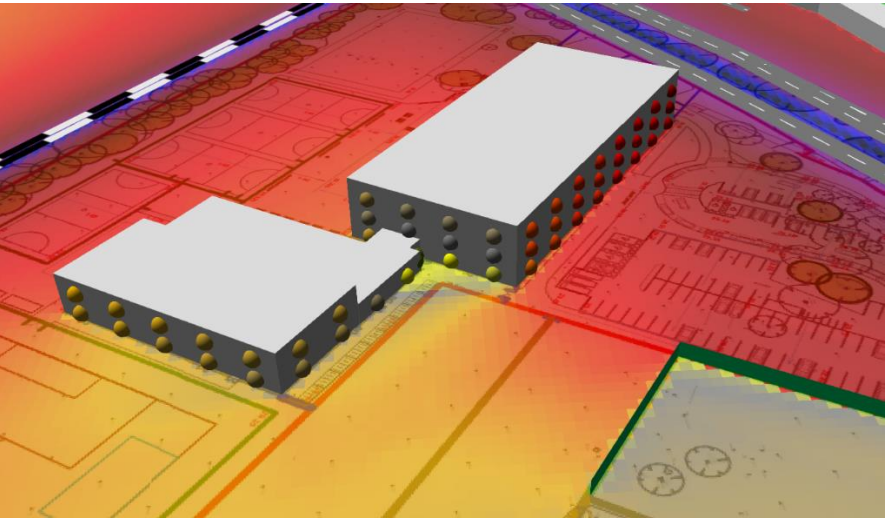


Figure 3: Indicative noise modelling 3D view screen shot.



A simple model has also been created to understand the effects of potential noisy activities on the proposed adjacent GMP plot (high level transient noise associated with police dog training).

The results of the noise survey and modelling exercise have been used to assess the required sound insulation of the building fabric, including glazing and ventilation.

Using environmental noise survey data from on-site measurements and results of environmental noise modelling, the proposed building envelope strategy for the new buildings associated with the proposed development has been assessed against criteria detailed in Section 3.

Based on the measured noise levels for worst-case, i.e. noisiest, daytime break-in noise at the locations of the proposed building façades, conventional external window, wall and roof build-ups and ventilation strategies will enable compliance with the criteria detailed in Section 3; further detail is provided in Section 6.

5.1.2 Acoustic modelling of sports pitch noise break-out

A 3D noise prediction model of the site has been created within CadnaA acoustic modelling software in order to determine predicted noise levels at the nearest or most exposed noise sensitive receptors due to noise generated from the proposed new sports pitches in line with guidance detailed in Sports England Artificial Grass Pitch (AGP) Acoustics - Planning Implications 2015.

A baseline model has been developed to enable calibration of the football pitch noise within the model to the following noise levels stated within Sports England guidance as representative of a typical AGP:

- “A typical free-field noise level of 58 dB $L_{Aeq}(1\text{ hour})$ at a distance of 10 metres (m) from the sideline halfway marking”
- “When a site is in an open location, noise levels of 50 dB $L_{Aeq}(1\text{ hour})$ can be achieved at a distance of 40 m [from the sideline halfway marking] at 1.5 m above the ground”

Sports England guidance expresses that the dominant noise sources from typical AGP sports sessions, including football and hockey, are shouting voices. These noise sources are most accurately modelled as point sources.

The following assumptions were made for a typical sports session (football) in order to calibrate the model:

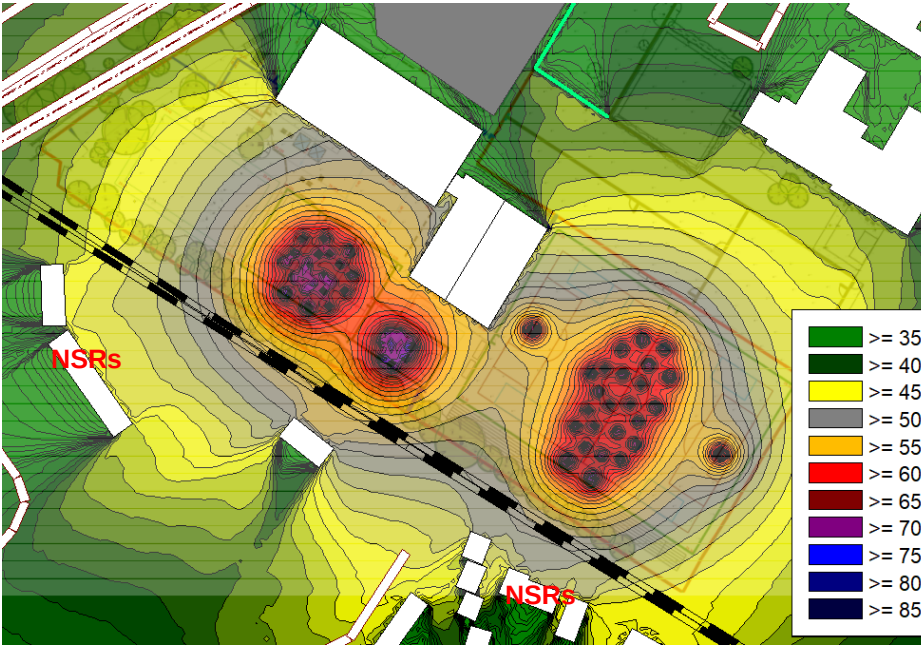
- The “on-time” of each player shouting will be a maximum of approximately 10% of the match duration.
- The majority of shouting activity occurs within the centre third of the pitch and from the goalkeepers.
- Typically, a football match has 2 coaching staff shouting from the side-lines with a maximum “on-time” of 25% of the match duration.

The baseline model which adopted the above assumptions was found to calibrate well with the Sport England stated representative AGP noise levels.

Following the baseline calibration model, a further model has been developed based on the proposed external layouts for the scheme, and the assumptions outlined were applied to each of the three sports pitch zones (i.e. AGP and 2no.MUGA areas) to provide a realistic worst case assessment of each zone being used simultaneously.

Figure 4 presents a contour plot from the CadnaA modelling of the site, which indicates the predicted noise levels at the façades of the nearest noise sensitive receptors due to sports pitch noise only.

Figure 4: CadnaA modelling screen shot presenting noise contour grid at 1.5m AGL, levels quoted in key are L_{Aeq} (dB)



Based on the modelling exercise undertaken, the noise levels presented in Table 7 are predicted due to noise egress from the proposed football pitch at the nearest/most exposed noise sensitive receptors:

Table 7: Noise levels at nearest noise sensitive receptors (NSR) due to noise egress from the proposed sports pitches

Noise sensitive receptor (NSR) location	Noise level at façade of NSR (dBA $L_{Aeq,1hour}$) due to noise egress from the proposed sports pitches
Residential properties off Weller Avenue	45
Residential properties off Ploughbank Drive / Pheasant Drive	49

As can be seen from the results in Table 7, noise levels at the façades of the nearest noise sensitive receptors due to noise egress from the proposed football pitch are all below 50 dB $L_{Aeq,T}$ and therefore achieve the proposed criteria detailed in Section 3.6.3.

6 Building Envelope

Noise break-in calculations have been undertaken to determine minimum performance values for building envelope elements on the basis of the measured and predicted noise levels established through the noise survey and modelling exercise.

6.1 Ventilation strategy

Where a natural ventilation strategy is adopted, it is typically the façade openings which are the weakest sound insulating element in the building envelope.

On the basis of the predicted noise levels incident upon the façades of the development, meeting normal ventilation requirements to teaching spaces via opening windows is not feasible from a noise perspective.

The ventilation strategy has been developed with the aim of maximising hybrid natural ventilation systems where possible to reduce annual energy consumption, while allowing the BB93 internal noise level criteria to be achieved, and in brief consists of:

- Perimeter hybrid mixed mode systems of natural/forced ventilation to teaching spaces where possible.
- Mixed mode ventilation to the sports hall.
- Elsewhere, mechanical ventilation in the form of perimeter mechanical ventilation with heat recovery, central ventilation with heat recovery and air source heat pumps, and dedicated extract ventilation will be provided.

Where mechanically ventilated, internal ambient noise level criteria will be achieved through the design and selection of M&E equipment and systems serving the spaces.

Perimeter hybrid/mixed mode unit data (Gilberts Mistrale 256) has been assessed for suitability and are capable of providing a suitable level of attenuation of external noise to achieve the IANL criteria within typical classrooms.

Based on the information provided by the project building physicist it is understood that that the upper end 'normal' operating duty for classroom NVHR units will be 320-340 l/s. The acoustic test data provided by the manufacturer provides a strong indication that the units are capable of meeting the BB93 mechanical noise sub-clause of the IANL criteria when operating in the normal design duty & installed in a configuration as proposed at CHSS.

6.2 External Windows

On the basis of the break-in calculations undertaken it is recommended that the external windows provide a minimum airborne sound insulation performance of R_w 33 dB. It should be noted that the above performance requirement relates to the overall window assembly (i.e. glazing and framework). This level of performance is achieved with typical thermal double glazed window units.

6.3 External Walls

6.3.1 Airborne sound insulation requirements

It is recommended that the external wall cladding system should provide a minimum airborne sound insulation performance of R_w 45 dB.

A number of external wall build-ups are proposed, all incorporate either brick or a lightweight cladding panel system, cavity with insulation, sheathing board, SFS zone, and 15mm Soundbloc plasterboard internal lining.

In some areas an enhanced internal lining is recommended to control flanking paths (refer Section 6.3.2).

The proposed build-ups have been reviewed during this design stage and are capable of providing a suitable level of airborne sound insulation performance to achieve the BB93 requirements.

6.3.2 Flanking sound insulation implications

Where partitions between noise sensitive adjacencies return to external walls, it should be noted that the cladding system should be suitably detailed to minimise flanking between spaces (refer Section 8)

The internal plasterboard lining should be built from slab to soffit and discontinued at junctions with internal walls. In addition, the external wall cavities at the junction with the separating walls and floors should be sealed, e.g. using a proprietary mineral fibre cavity stop with a minimum density of 100 kg/m³.

Current proposals indicate an internal plasterboard lining consisting of 1no layer 15mm soundbloc (or equivalent mass); with regard to flanking sound insulation performance, we provide the following commentary:

- The proposed plasterboard lining will provide a sufficient flanking performance where the separating partition is rated R_w ≤50 dB.
- Where separating partitions are rated R_w >50 dB, it is recommended to include a minimum 25mm mineral wool insulation (density range 10-45 kg/m³) in the lining cavity into the cladding system build up.
- It is recommended that to provide a suitable level of flanking sound insulation performance between music rooms and adjacent spaces, an additional layer of plasterboard is provided to the external wall internal lining, i.e. 2 no. layers total, with 25mm mineral wool (density range 10 -45 kg/m³).

6.4 External Roof

6.4.1 Airborne sound insulation requirements

It is recommended that the proposed lightweight roof system should provide a minimum airborne sound insulation performance of R_w 35 dB to meet typical BB93 internal noise requirements.

6.4.2 Rain impact noise insulation requirements

To control rain impact noise within BB93 limits, the proposed lightweight roofing will provide the following performance:

- General Classrooms ≤ L_{IA} 52 dB,
- Music Classroom ≤ L_{IA} 51 dB,
- Music Practice ≤ L_{IA} 53 dB,
- Offices ≤ L_{IA} 56 dB,
- Main Hall ≤ L_{IA} 54 dB,
- Sports Hall & Activity Studio ≤ L_{IA} 58 dB,

6.4.3 Proposed constructions

On the basis of the information provided by the design team, the following roof build-ups are proposed:

Sports Hall Roof

- Structural profiled metal deck, perforated with mineral wool profile inserts (D159, or equivalent absorption performance, refer Section 9.3.4.1)
- Single ply system build-up incorporating:
- Total 235mm mineral wool insulation (Rockwool Hardrock multifix, or equivalent), double layered with 150mm and 85mm.

Main Building & Single Story Roof

- Structural profiled metal deck
- Bituminous single ply roof system (Moy Paralon or equivalent performance), consisting of
- 3mm aluminium lined elastomeric bitumen vapour barrier
- PIR insulation 140mm
- 3mm glass fibre reinforced bitumen underlay
- Paralon bitumen cap sheet

The proposed roof constructions, are capable of providing a suitable level of airborne and rain impact sound insulation, when taking account of the full separating build-up, i.e. with suspended ceilings beneath (with the exception of the sports hall).

6.4.4 Flanking sound insulation implications

Generally across the scheme, the proposed roof constructions are anticipated to be capable of providing a suitable level of flanking sound insulation performance between adjacent spaces, when taking account of the full separating build-up, i.e. with suspended ceilings beneath.

6.4.4.1 Music Spaces

Between the music rooms and adjacent areas an enhanced flanking sound insulation performance is required to allow the BB93 on-site sound insulation performance requirements to be achieved.

Full suspended ceilings are proposed in the music rooms. In order to provide a suitable level of flanking sound insulation the following is recommended:

- Ceiling finish consisting of Echophon Combison Duo A, or equivalent absorptive & flanking performance ($0.95 \alpha_{Tmf}$, D_{nfw} 42 dB respectively).
- 50mm mineral wool insulation (density range 10-45 kg/m³) within the ceiling void.
- Conventional light fittings and no open return air grilles within the ceiling finish.

6.4.4.2 Activity Studio

An enhanced flanking sound insulation performance is required between the activity studio and the sports hall to allow the BB93 on-site sound insulation performance requirements to be achieved, and between the plant room and the activity studio to reduce flanking transmission of plant noise through the roof construction.

A full suspended ceiling is proposed in the activity studio. In order to provide a suitable level of flanking sound insulation the following is recommended:

- Ceiling finish consisting of Echophon Combison Duo A, or equivalent absorptive & flanking performance ($0.95 \alpha_{Tmf}$, D_{nfw} 42 dB respectively).
- 50mm mineral wool insulation (density range 10-45 kg/m³) within the ceiling void.
- Conventional light fittings and no open return air grilles within the suspended ceiling finish.

6.4.5 Rooflights

To adequately control rain impact noise, it is recommended that roof glazing consists of a double glazed construction with a minimum performance of R_w 33dB.

7 Internal Sound Insulation

7.1 Internal Walls

Floor plans have been marked up to provide minimum sound insulation performance requirements for the internal walls within the scheme, presented in Figure 5 to Figure 7.

All R_w 45 dB rated walls should include at least 25 mm mineral wool insulation (density range 10 to 45 kg/m³).

For ease of comparison with manufacturer’s data, the separation requirements for separating walls have been marked up in terms of the required R_w performance. Example wall build-ups to achieve various R_w acoustic ratings are included in Table 8.

For drywall partitions, the drywall supplier will be responsible for confirming the build-up requirements necessary to achieve the R_w ratings specified.

Some walls on the mark-ups are marked with ‘Block’. This indicates where the wall is recommended to be a masonry build-up, rather than a drywall partition, to provide enhanced low frequency sound insulation. Should drywall partitions be used, ratings to these walls may need to increase.

It should be noted that the sound insulation mark-ups presented here represent a record of the input during the design development; where subsequent layout changes have occurred recommendations have been provided to the architects with regard to sound insulation requirements; a review of the architects proposed partition layout plans has been undertaken.

Table 8: Example partition constructions

Minimum R _w dB	Example drywall constructions
R _w 40 dB	15mm SoundBloc (or equivalent) on each side of 70 mm metal studs at 600 mm centres.
R _w 45 dB	12.5mm SoundBloc (or equivalent) on each side of 70 mm metal studs at 600 mm centres; 25 mm Isowool APR 1200 insulation in the cavity.
R _w 50 dB	2 x 12.5mm SoundBloc (or equivalent) on each side of 70 mm metal studs at 600 mm centres; 25 mm Isowool APR 1200 insulation in the cavity.
R _w 55 dB	2 x15mm SoundBloc (or equivalent) on each side of 70 mm metal studs at 600mm centres. 50mm Isowool APR1200 in the cavity.
R _w 60 dB	2 x 12.5mm SoundBloc (or equivalent) and 2mm plaster skim on each side of 92 mm Acoustuds at 600mm centres. 100mm Isover modular roll in the cavity.
R _w 63 dB	19mm Gyproc Plank and 12.5mm SoundBloc (or equivalent) on each side of 70 mm metal studs at 600mm centres with a Gypframe RB1 Resilient Bar. 50mm Isowool APR1200 in the cavity.

During this design stage a review of the suitability of the proposed partition layout plans has been undertaken and comments provided to the Architects with regard to meeting the BB93 performance criteria.

7.1.1 Plant room / Activity Studio adjacency

Between these spaces it is recommended that the separating partition consists of a masonry construction offering a minimum R_w 50 dB sound insulation performance.

This could be achieved with 140mm medium density blockwork (min. 1450kg/m3) incorporating a lining to one side consisting of 1 layer of 12.5mm wallboard (or equivalent) on Gypframe GL1 Lining Channel fixed to one side to give 35mm cavity. Cavity to be filled with 25mm mineral wool.

The above recommendation is provided on the basis of an assumed typical reverberant noise level within the plant room of 75dBA.

7.1.2 Glazed partitions & screens

The acoustic performance of glazed partitions can be limited due to the nature of the system, i.e. structural connections, loading requirements, small cavity depths. Conventional glazed partitions cannot typically achieve R_w ratings above 50 dB. Bespoke glazed partitions incorporating twin frames and thick acoustic laminated panes will likely be required for higher R_w ratings. R_w performance requirements apply to the complete glazing assembly i.e. including frame, seals etc. Laboratory test certification should be provided for the final selected glazing assemblies.

On the basis of the internal glazed screen mark-up provided by the architects, we offer the following recommendations to achieve the BB93 sound insulation requirements:

Where small glazed screens / vision panels are associated with doorsets, these should provide an acoustic performance equal to that of the door (i.e. R_w 30-35 dB).

- *Level 0 Internal glazed screen between RM.00.70 Office(1P) & CR.00.11 Community Ent.:* Glazed screen offering a performance of R_w 40 dB
- *Level 0 Internal glazed screen between RM.00.74 Office/Meeting & SC.00.03 Stair:* Glazed screen offering a performance of R_w 48 dB
- *Level 0 Internal glazed screen between RM.00.07 Library & CR.00.03 Circulation:* Glazed screen offering a performance of R_w 45 dB
- *Level 1 Internal glazed screen between SEN resource/circulation/Library Breakout & adjacent circulation space:* Glazed screen offering a performance of R_w 40 dB
- *Level 1 Internal glazed screen between SEN resource/circulation/Library Breakout & RM.00.16 Dining Room (light well):* Glazed screen offering a performance of R_w 41 dB
- *Level 1 Internal glazed screen between RM.01.19 SEN Therapy & RM.00.21 Dining Room (light well):* Glazed screen offering a performance of R_w 43 dB
- *Level 1 Internal glazed screen between RM.01.22/RM.01.23/RM.01.26/ RM.01.28 Group rooms & RM.00.21 Dining Room (light well):* Glazed screens offering a performance of R_w 48 dB
- *Level 1 Internal glazed screen between Rm.01.18 SEN Resource / circulation / breakout & RM.00.21 Dining Room (light well):* Glazed screen offering a performance of R_w 41 dB
- *Sliding vision panel between RM.01.37 Control room & RM.00.28 Main Hall:* Sliding screen of nominal acoustic performance set within a wall rated at R_w 45 dB, in accordance with the BB93 sound insulation exception re: main hall control rooms.

It may be noted that for the purposes of satisfying the Building Regulations (Part E), BB93 performance requirements apply to teaching and learning spaces only, therefore a lower level of sound insulation than that recommended within BB93 may be considered if there are practical limitations with the glazing system between these ancillary spaces – if this approach is to be adopted we would recommend it should be discussed and agreed with stakeholders and a lower rated glazed screen than stated above specified.

7.1.3 Movable partitions

Where there is a moveable partition between teaching areas, BB93 states that the on-site airborne sound insulation performance between the spaces should be at least D_{nT,w} 40 dB.

We recommend that R_w 55 dB rated moveable walls be provided between the adjacencies detailed above. It should be noted that this rating is for the complete assembly (i.e. all components, not just the wall panel).

We recommend that the moveable wall supplier provide field test data to confirm that the moveable partitions proposed are capable of achieving an on-site figure of R’_w 40 dB.

Any fixed partition areas bordering the moveable partition (e.g. partition bulkheads) should also be rated at R_w 55 dB.

7.2 Internal Doors

Door set ratings have been included on the acoustic sound insulation mark ups (Figure 5 to Figure 7) in accordance with BB93 requirements.

Generally, R_w 30 dB doors are proposed between typical teaching spaces and circulation areas; R_w 35 dB doorsets are proposed to areas of increased activity noise or increased sensitivity to noise (e.g. music, SEN spaces respectively).

To achieve these acoustic performance ratings, doorsets will require either insulated metal doors, solid core timber doors or double glazed glass doors. All door assemblies will require full perimeter seals, including threshold, and no ventilation grilles

7.2.1 Interconnected spaces

Where spaces are required to be interconnected for operational or health and safety reasons, walls and doors between interconnected spaces have been rated in line with BB93 guidance. BB93 notes that the level of acoustic separation is limited where spaces are interconnected, and may require management depending on the noise generation and sensitivities of the activities within (e.g. Main Hall / Dining, Drama / Graphics).

7.2.2 Plant room and riser doors

Plant room and riser doors may also need to be acoustically rated depending on expected plant noise levels and the sensitivity of the adjacent area local to the door. Suitable ratings for the CHSS scheme are presented in the sound insulation mark-ups.

7.3 Separating Floors

Calculations have been undertaken to establish the separation requirements to achieve the BB93 on-site airborne and impact sound insulation performance requirements.

The proposed intermediate floor slab consists of a 150mm thick composite concrete re-entrant profile deck (150mm comflor 51, or equivalent mass).

In coordination with a full suspended ceiling beneath in the absence of open air transfer grilles, the proposed overall separating build-up is capable of providing a suitable airborne sound insulation performance for the scheme adjacencies.

In order to allow compliance with the impact sound insulation performance criteria, we offer the following recommendation with regard to floor finish impact sound insulation requirements:

- Internal spaces (except unoccupied plant/equipment/store rooms) located above occupied spaces generally - A minimum performance of ΔL_w 18 dB (Weighted reduction in impact sound pressure level) – this can typically be achieved by a carpet finish, rubber finish or hard floor finish incorporating a resilient underlay, e.g. Regupol 4515 multi under vinyl.

As outlined in Section 3.7, for the purposes of assessment, the SEN accommodation has been assigned BB93 room types in accordance with the SOA issued to the design team. Should the assignments be revised to result in more onerous criteria, the separating elements between dining and SEN group spaces would need to be enhanced, e.g. underdrawn with plasterboard barrier ceiling.

Figure 5: Horizontal sound insulation mark-ups – Level 00

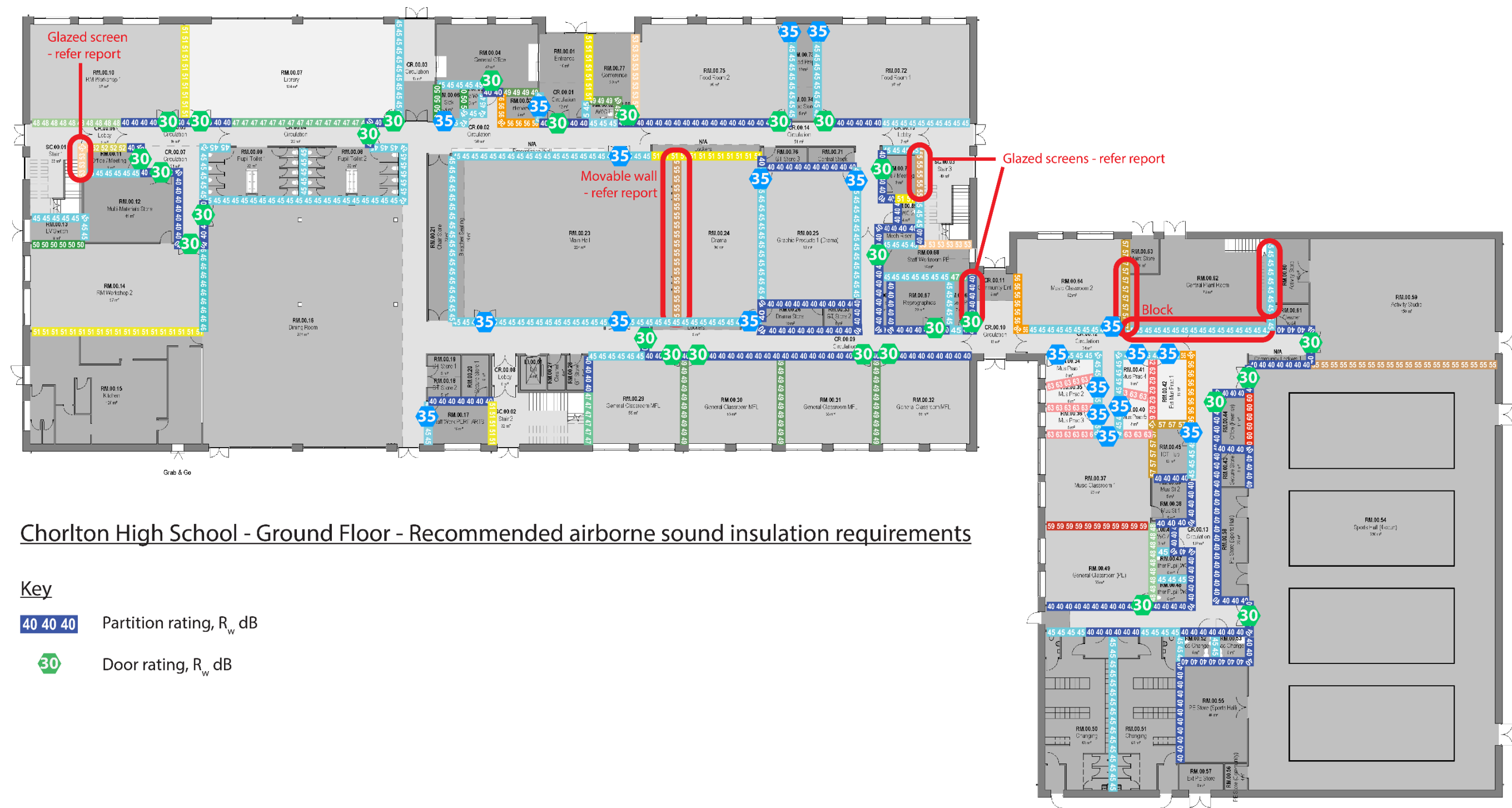
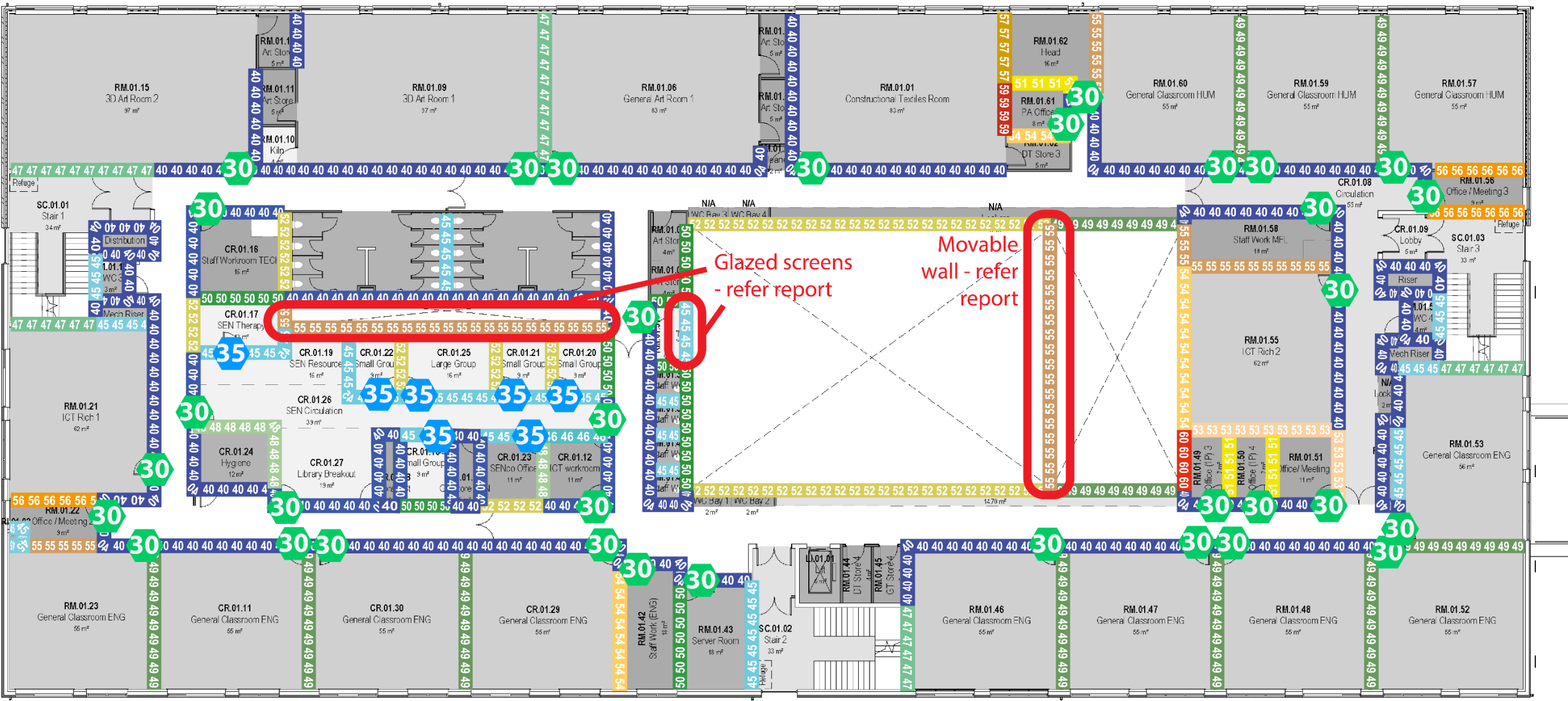


Figure 6: Horizontal sound insulation mark-ups – Level 01



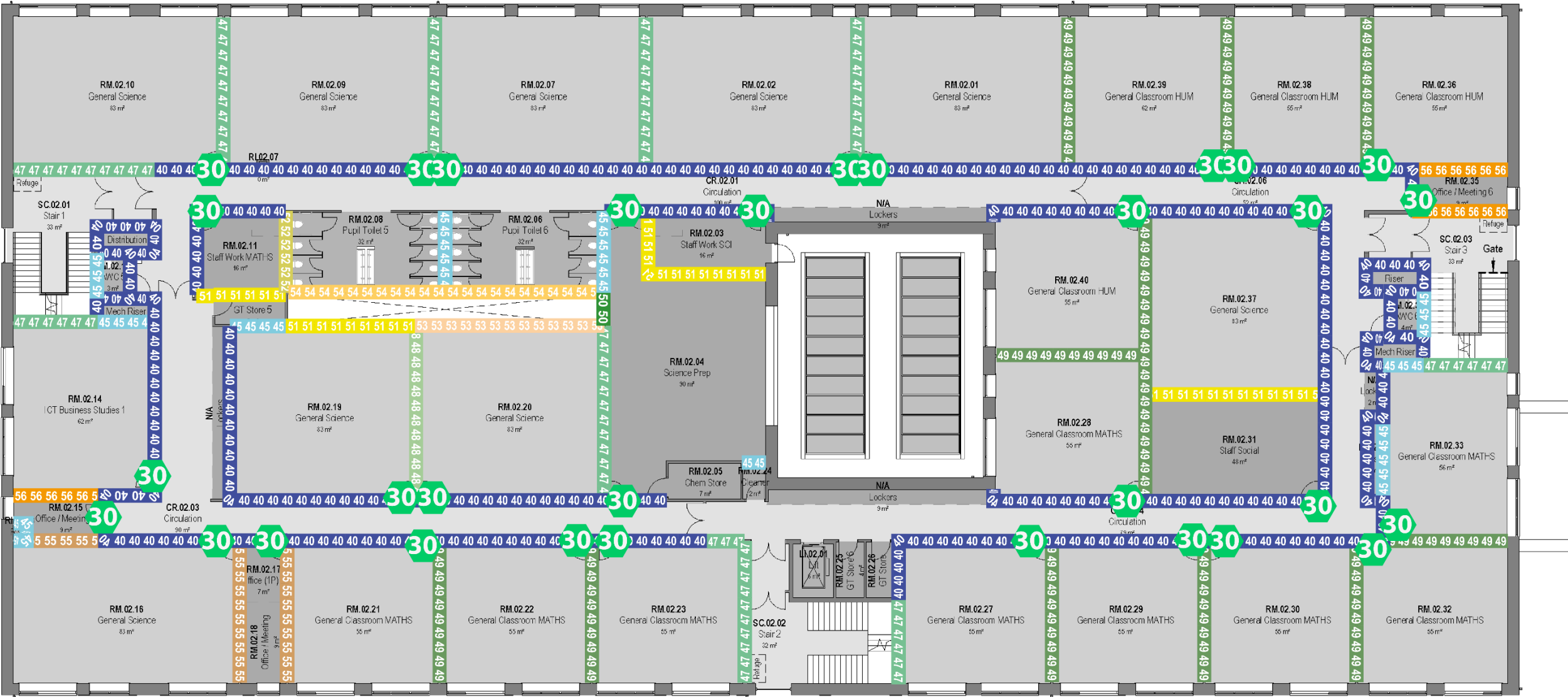
Chorlton High School - First Floor - Recommended airborne sound insulation performace

Key

40 40 40 Partition rating, R_w dB

30 Door rating, R_w dB

Figure 7: Horizontal sound insulation mark-ups – Level 02



Chorlton High School - Second Floor - Recommended airborne sound insulation requirements

Key

40 40 40 Partition rating, R_w dB

30 Door rating, R_w dB

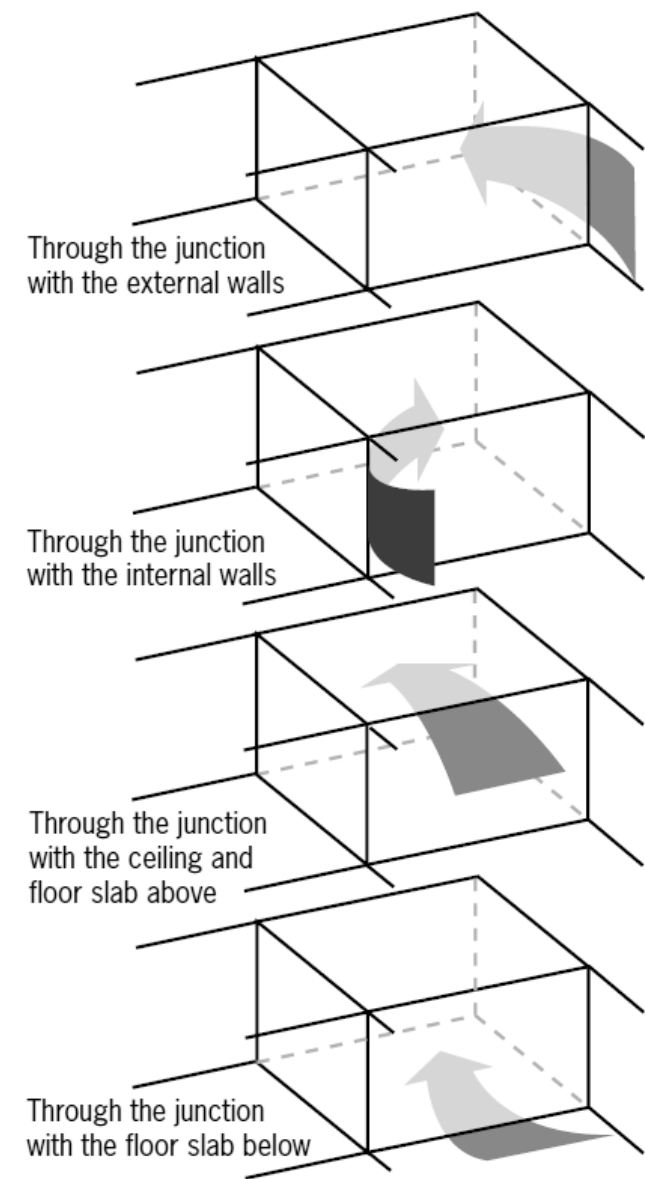
8 Junction Detailing

In order to control flanking noise transmission between noise sensitive spaces, careful detailing at junctions is necessary.

Partitions should be constructed full height from structural base slab to structural soffit and should be well sealed at these junctions using flexible acoustic sealant.

All penetrations and junctions will need to be carefully detailed to ensure that the acoustic performance of the walls and floors are not degraded or bypassed. Figure 8 provides an illustration of the main flanking paths.

Figure 8: Main flanking paths (from BB93)



8.1 Acoustic Detailing Principles

We recommend that the following junction detailing principles are implemented. It should be noted that these details are general principles only and will need to be developed and adapted for specific locations.

- All partitions should be built full height from structural floor slab to structural floor slab.
- Any 'floating' screeds installed above insulation (rather than being bonded to the structural slab) would need to be discontinued at junctions with internal partitions and the screeds should have no rigid connections to the perimeter walls or structural elements. Typical junction detailing principles for floating floor junctions with partitions are presented in Figure 9;
- Building envelope elements which run common between adjacent internal spaces must be designed to ensure that the flanking sound insulation performance of the building element does not degrade the sound insulation performance requirement between adjacent spaces.
- All corridor partitions should be discontinued at junctions with separating walls. At junctions between separating masonry walls and internal flanking partitions, the separating wall should be carried through the flanking wall to discontinue the flanking wall across the junction;
- For separating drywall partitions rated $\geq R_w$ 45 dB, the internal lining of drywall corridor partitions should be discontinued at junctions with separating walls and a cavity stop or mineral wool packing should be installed to close any cavity formed at the partition junction. Refer to Figure 11 for principles.
- The principles above should be applied at the internal lining of the external wall constructions if present, i.e. internal lining discontinued either side of the separating partition with the separating construction carried through, and any cavity formed in the junction closed with mineral wool packing or a cavity stop.
- Where separating walls meet the underside of the soffit or roof, an acoustic deflection head detail will be required to minimise flanking sound. Example deflection head details illustrating acoustic principles are shown in Figure 12 to Figure 16.
- For blockwork head deflections of 20 mm or less, the gap at the head should be packed to the full depth of the block with mineral wool and the joint sealed on both sides with non-setting acoustic sealant;
- For blockwork head deflections between 20 and 40 mm: The gap at the head should be packed to the full depth of the block with mineral wool and the joint sealed on both sides with a board material providing a minimum mass per unit area of 9.8 kg/m^2 (e.g. 1 layer of 15 mm Gyproc gypsum board or equivalent). A non-setting sealant should be used at joints between the block, board and slab underside;
- All building service penetrations and common services between rooms must be adequately treated so that flanking sound transmission between services does not degrade the sound insulation performance between adjacent spaces. Refer Section 8.3 of this document.

During this design stage various details have been forwarded for review and comments provided to the architects to incorporate within their work packages.

Figure 9: Recommended partition base junction with floating screed acoustic detailing principles (same principles apply for blockwork partitions)

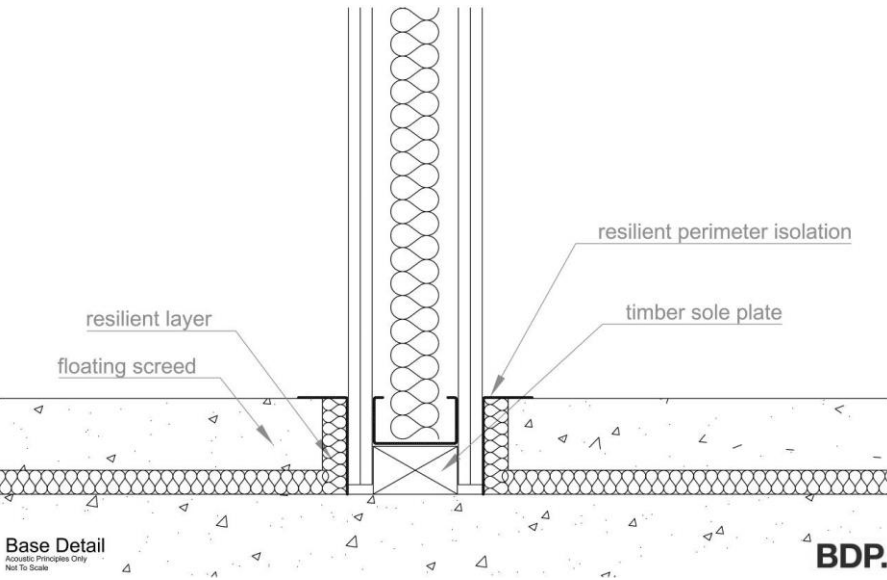


Figure 10: Recommended acoustic junction detailing principles for separating and flanking blockwork walls

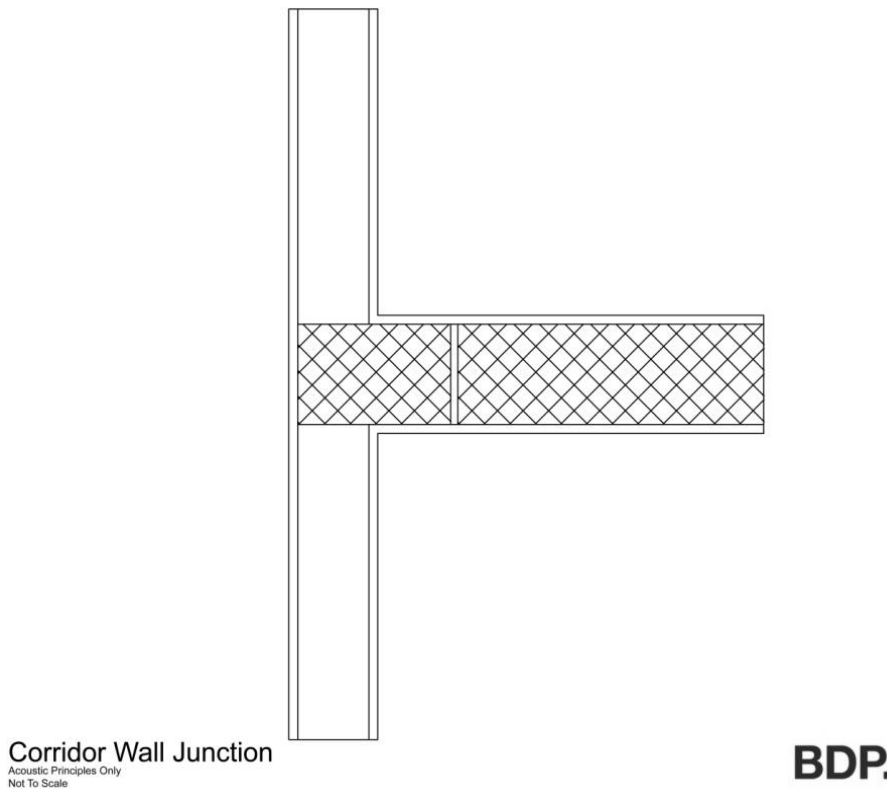


Figure 11: Example British Gypsum detail demonstrating acoustic junction detailing principles for drywall separating walls and internal drywall flanking walls; and flanking internal lining of external walls

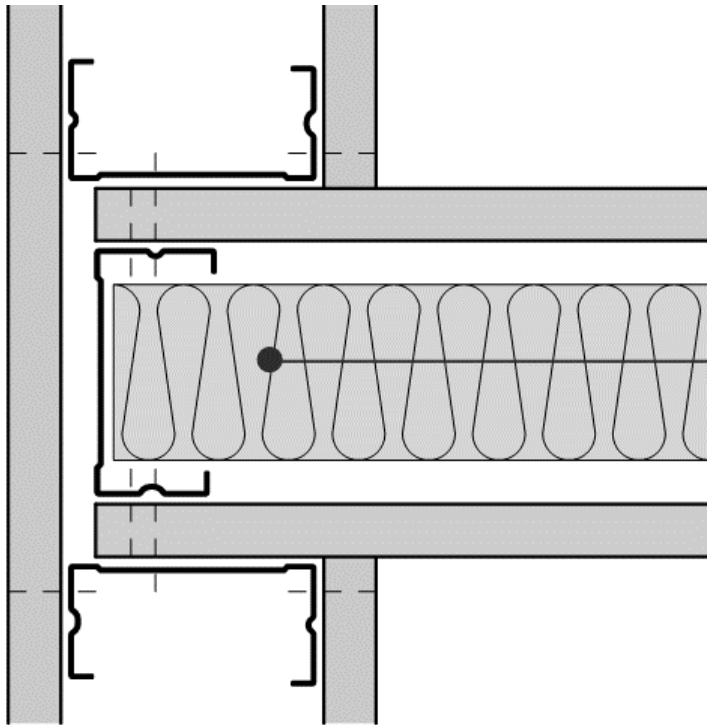
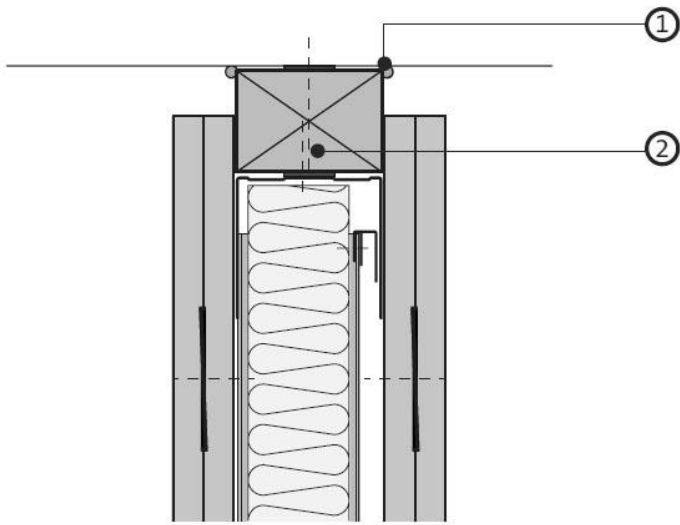
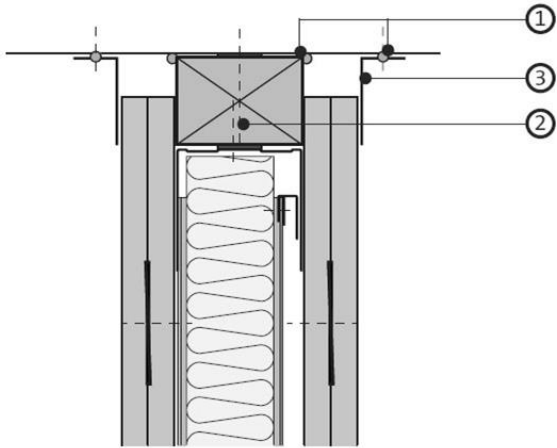


Figure 12 Example British Gypsum deflection head detail which be suitable for partitions rated $\leq R_w$ 45 dB



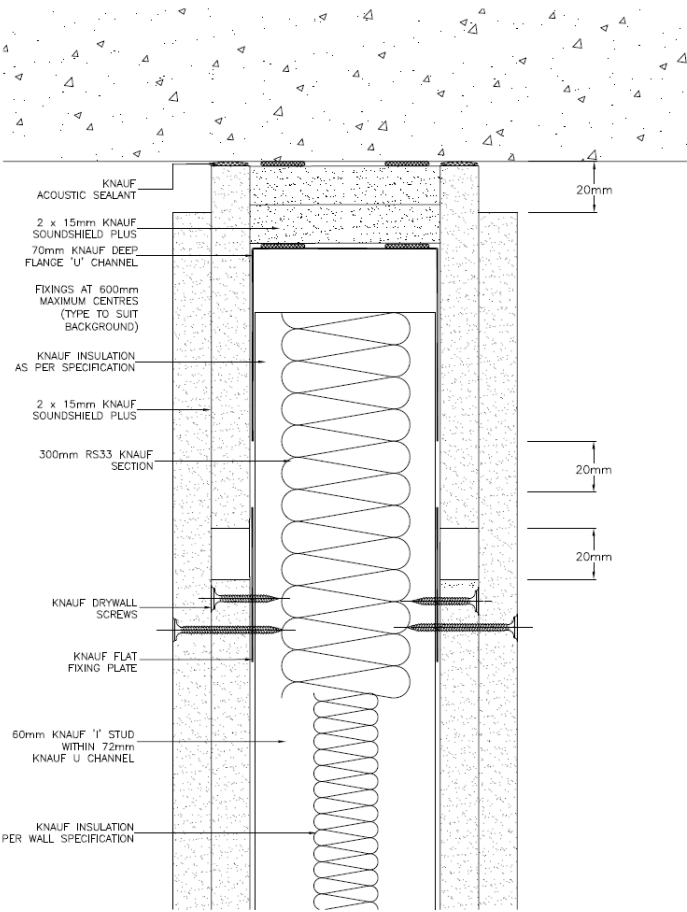
- 1 Gyproc Sealant for optimum sound insulation
- 2 50mm timber head plate equivalent to channel width forming fire-stop

Figure 13 Example British Gypsum deflection head detail which would be suitable for partitions rated $> R_w$ 45 dB



- 1 Gyproc Sealant for optimum sound insulation
- 2 50mm timber head plate equivalent to channel width forming fire-stop
- 3 Gypframe GA4 Steel Angle to minimise loss of sound insulation performance due to air leakage

Figure 14: Alternative example Knauf deflection head detail which would be suitable for partitions rated $> R_w$ 45 dB



8.2 Partition junctions with profiled floor slabs and roof decks

Figure 15 and Figure 16 below illustrate the acoustic principles for junctions where partitions meet a profiled deck or roof liner.

Figure 15: Recommended acoustic junction detailing principles with profiled deck – along profile (same principles apply for blockwork walls)

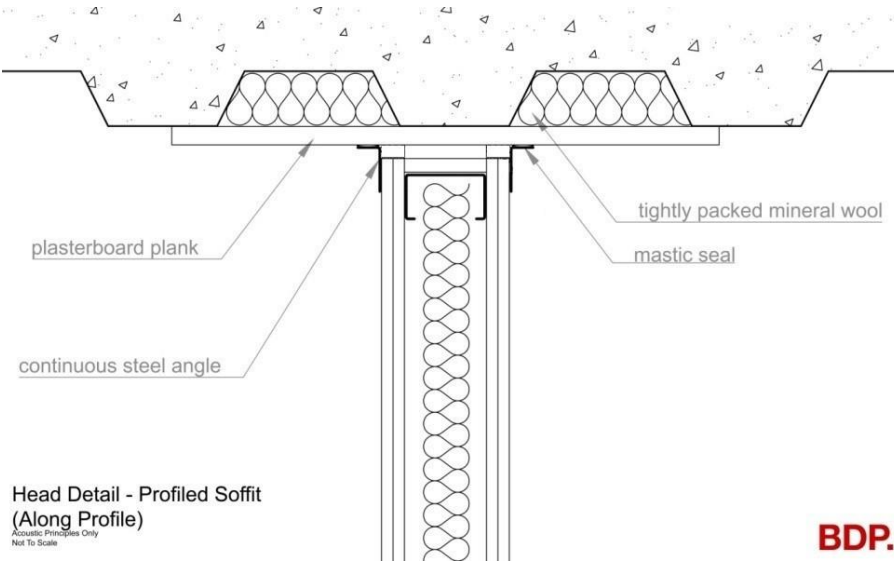
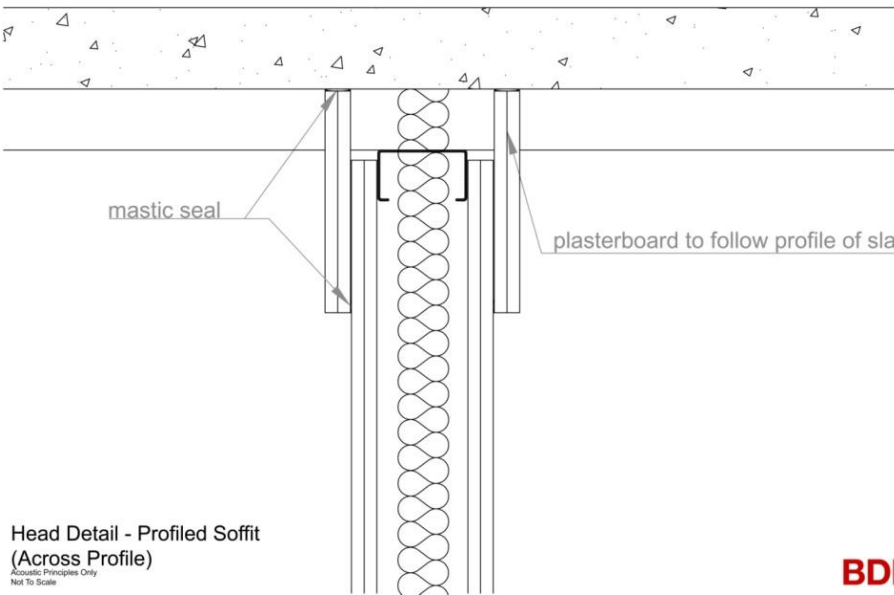


Figure 16: Recommended acoustic junction detailing principles with profiled deck – across profile (same principles apply for blockwork walls)



An alternative to the detail presented in Figure 16 is as follows:

R_w 45 dB rated partitions and below – Install a PFC Corofil C144 Firestop Block with Fastight Paint coating to both faces (or equivalent) to the full thickness of the partition.

The block should be cut tight to the profile and the perimeter sealed with acoustic mastic on both sides.

Partitions rated higher than R_w 45 dB – Install a 250 mm long PFC Corofil C144 Firestop Block with Fastight Paint coating to both faces (or equivalent), centred over the partition. The block should be cut tight to the profile and the perimeter sealed with acoustic mastic on both sides. Where necessary, provide a board underneath any length of the firestop block which protrudes past the blockwork. The board under the firestop block should be a similar density to plasterboard and have a minimum mass per unit area of 15 kg/m^2 .

8.3 Service Penetrations

Where possible, it is recommended to avoid service penetrations through acoustically rated separating partitions between sensitive spaces. To maintain the necessary sound insulation performance, all services penetrations through rated partitions should be effectively sealed by packing any holes tightly with mineral wool and sealing with flexible sealant. Where larger holes ($>12\text{mm}$) are present a plasterboard blanking panel / metal collar will be required around the penetrations. Figure 17 and Figure 18 present the recommended detailing principles for service penetrations. Subject to the specific scenario, in some cases ablative coated mineral fibre batts arrangements can be used to detail service penetrations, typically this would be within lower rated partitions (e.g. corridor walls featuring doorsets), or small penetration areas.

Figure 17: Recommended acoustic detailing principles for duct or pipe penetration through a single leaf drywall partition (the same principles apply to masonry walls however the collar linings should be of sufficient build-up to achieve the R_w performance ratings stated in the sound insulation performance mark-ups and the opening in the wall should be restricted to the size required to allow a practical installation of the building service element)

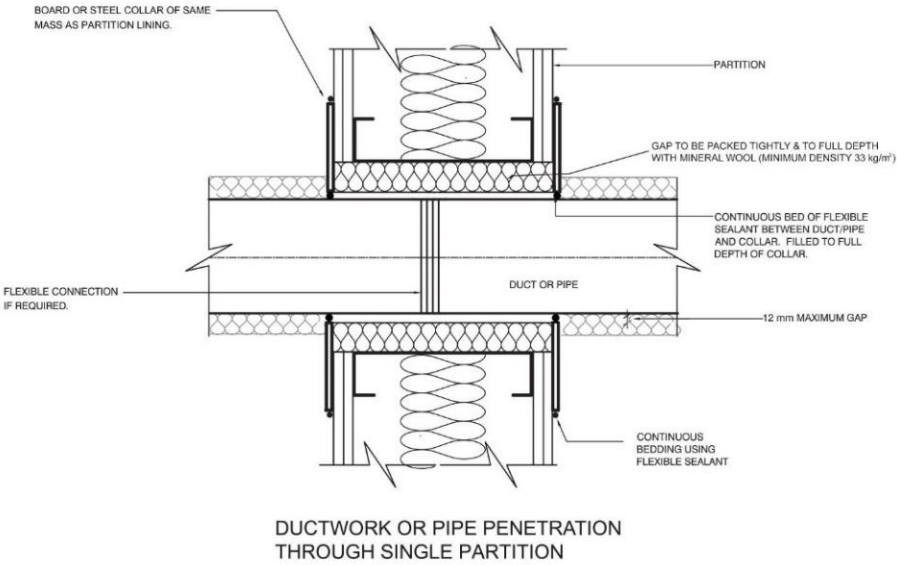
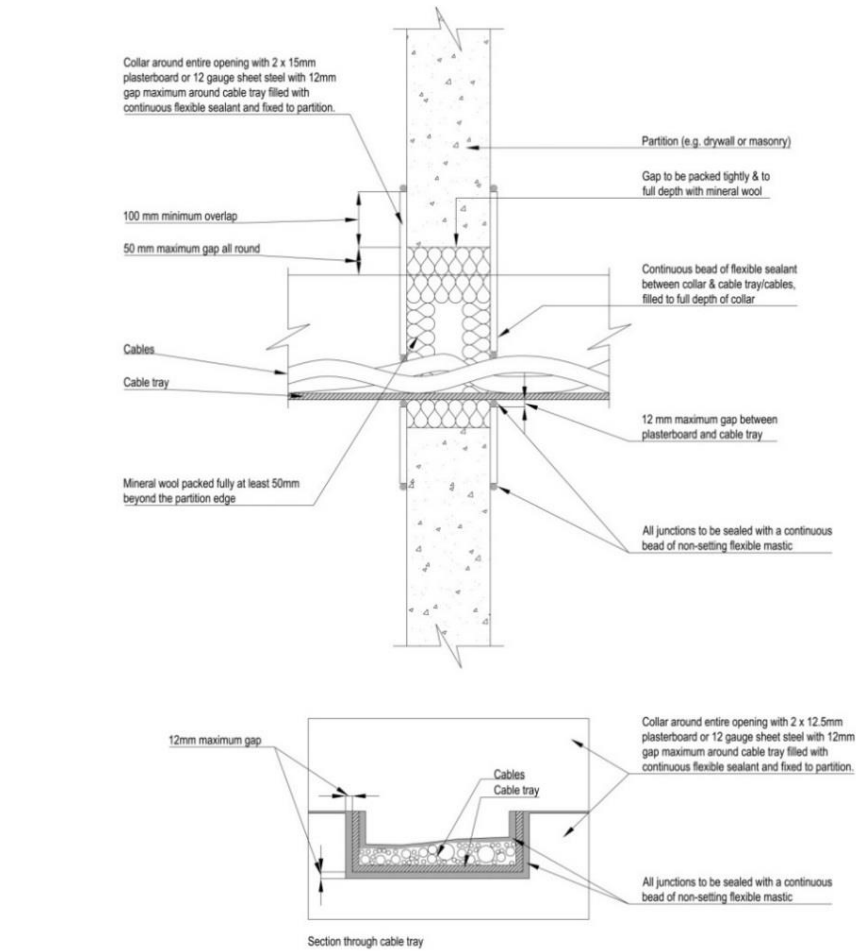


Figure 18: Recommended acoustic detailing principles for cable tray penetration through a single leaf wall

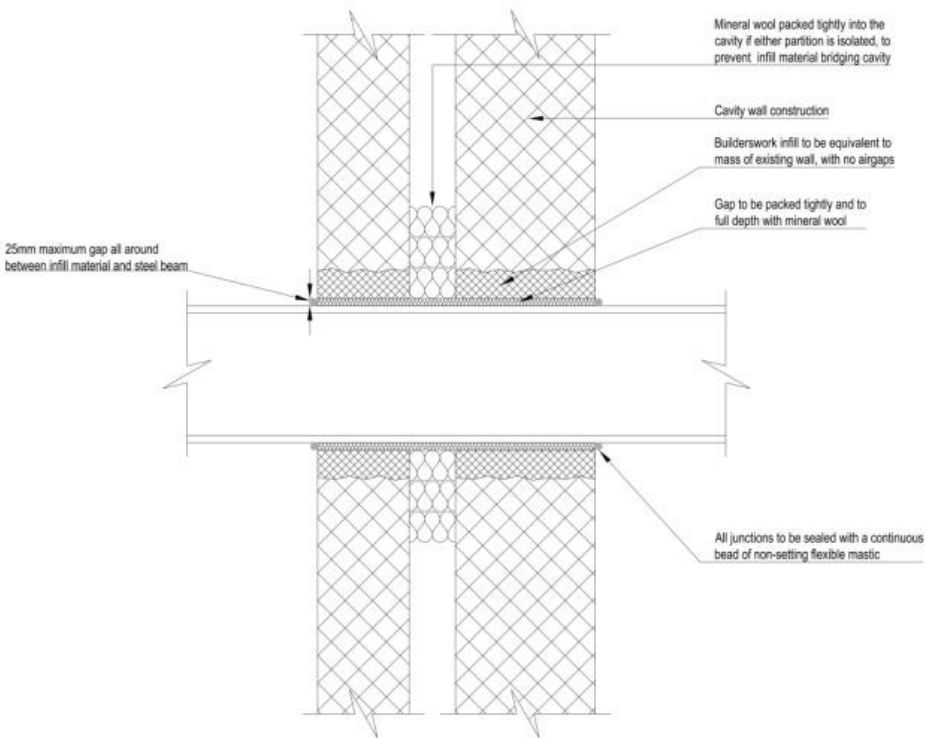


Cable Tray Penetration Through Single Leaf Wall
Acoustic Principles Only
Not To Scale

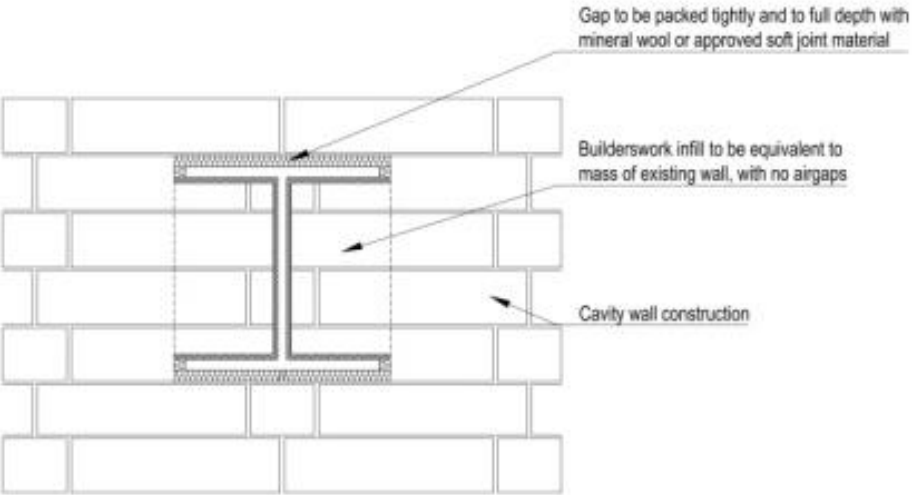
8.4 Steelwork Penetrations

Figure 19 presents our recommended detailing principles for sealing steelwork penetrations. Where steel beams are located parallel above partitions, in the first instance we recommend that the partition linings are carried around the steel beam to the soffit underside.

Figure 19: Recommended acoustic detailing principles for steelwork penetration



Steel Beam Penetration Through Double Leaf Wall
Acoustic Principles Only
Not To Scale



8.4.1 Steelwork enclosures

8.4.1.1 Beam enclosures

During this design stage, a review of the preliminary steel beam boxing strategy has been undertaken; recommendations relating to the proposed detailing, as well as the expected level of performance for the various enclosure types have been provided to the architects and design team; a review of ground floor proposed boxing strategy layouts has been undertaken and recommendations provided such to allow the BB93 horizontal sound insulation criteria to be achieved where partitions abut enclosed beams.

8.4.1.2 Column enclosures

The following section outlines a preliminary column boxing strategy, which will be refined as the design progresses. Indicative detailing principles are demonstrated in the example British Gypsum details below:

Figure 20: Indicative column boxing, principle anticipated to be suitable for separating partitions rated $R_w < 50$ dB

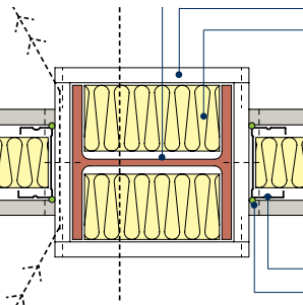


Figure 21: Indicative column boxing, principle anticipated to be suitable for separating partitions rated $R_w < 55$ dB

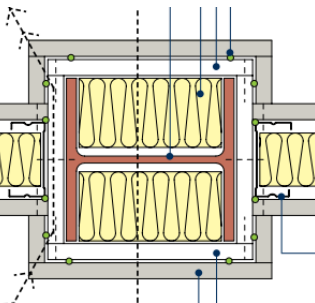
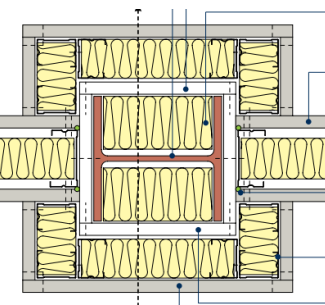


Figure 22: Indicative column boxing, principle anticipated to be suitable for separating partitions rated $R_w < 60$ dB



9 Room Acoustics

It is essential to suitably control reverberation within teaching and learning spaces to facilitate a good acoustic environment for critical listening activities.

Reverberation time calculations and 3D room acoustic modelling has been undertaken, as required, to appraise the proposed absorption strategy and provide recommendations such to allow the BB93 performance criteria to be achieved.

9.1 Acoustic absorber performance requirements

Typically acoustic absorption is specified in terms of absorbency class (Class A, B, C etc). However as BB93 requirements predominantly relate to mid-frequency reverberation time (T_{mf}), consequently, absorber performance requirements to achieve BB93 T_{mf} criteria are specified in terms of the arithmetic average practical absorption coefficient across the 500Hz -2kHz frequency bands (α_{tmf}).

Table 9: Absorption performance requirements

Equivalent mid-frequency absorption	Octave band centre frequencies (Hz)		
	500	1k	2k
Class A	0.90	0.90	0.90
Class C	0.60	0.60	0.60

Where specified, the proposed architectural finishes have been referenced from the ceiling finishes plans provided by the architects – these refer to various Ecophon absorption systems as full suspended ceiling coverage; the relevant manufacturers absorption performance have been used in the calculations undertaken – any proposed substitution should offer an equivalent performance and be reviewed for suitability by the acoustic consultant. Refer Table 10.

It is worth noting that the ceiling layout plans provided refer to a Combison dB A; from a review of the available data, we recommend this is revised to Combison Duo A, based on the flanking and absorption performance (refer Section 9.2.2).

Table 10: Proposed absorber system acoustic performance

Ecophon product	Practical absorption coefficient (ap) at octave band frequency (Hz)					
	125	250	500	1000	2000	4000
Gedina A	0.45	0.90	1.00	0.85	0.95	0.95
Sombra A	0.35	0.80	1.00	0.85	1.00	1.00
Combison Duo A	0.35	0.65	0.90	1.00	1.00	0.95
Akusto Wall C - Super G (Wall panel)	0.25	0.75	1.00	1.00	1.00	1.00

Note: Ceiling system absorption data presented for 200mm suspension depth; wall panel 50mm ODS.

9.2 Typical enclosed spaces

Across the scheme acoustically absorbent finishes are generally proposed to be provided in the form of full suspended ceilings with acoustic ceiling tiles.

On the basis of the acoustic absorption performance of the proposed ceiling finishes (referenced from the Architects ceiling finishes plans, (5137_02700 Rev P01) the results of the calculations undertaken indicate that the current proposals are generally capable of meeting the BB93 T_{mf} reverberation time criteria.

In large volume spaces and room types with more onerous reverberation time criteria, wall absorption will also be required to satisfy BB93 requirements.

Absorption should be evenly distributed throughout the space, wall absorption should be provided to a minimum of 2 non-parallel walls at heights no greater than 3m.

Based on preliminary calculations, the following indicative strategies will be required.

9.2.1 SEN accommodation

In the SEN accommodation (SEN Group and Therapy spaces) a more onerous BB93 reverberation criteria applies. It is noted that the preliminary ceiling finishes drawings referenced Ecophon Extra Bass ceiling system, which provides an improved low frequency absorption performance; On the basis of our modelled results the use of full soffit coverage with Extra Bass would still require additional wall panels to meet the performance criteria; therefore we would recommend that a standard class A ceiling tile system (i.e. Gedina A) can be used along with:

- 2m² acoustic wall panels (Akusto Wall C or equivalent), distributed across two non-parallel walls.

9.2.2 Music rooms

9.2.2.1 Flanking sound insulation performance

Between the music rooms and adjacent areas an enhanced flanking sound insulation performance is required to allow the BB93 on-site sound insulation performance requirements to be achieved; recommendations are provided in Section 6.4.4.1.

9.2.2.2 Music Practice rooms

In the small music practice rooms, in addition to the suspended ceiling finish, wall absorption should be provided to allow the BB93 reverberation time criteria to be achieved. The following is recommended (refer Table 10):

- Ceiling finish: full coverage Ecophon Combison Duo A, or equivalent.
- Wall panels: minimum 1m² wall panel, Ecophon Akusto Wall C, or equivalent

9.3 Large Volume Spaces

9.3.1 Main Hall

Acoustic modelling results indicate that the BB93 reverberation time criteria in the Main Hall is predicted to be achieved based on the following:

- Full suspended ceiling absorption (as per architect’s proposals) Ecophon Gedina A, or equivalent.
- Wall panels: 76m² Acoustic wall panels providing minimum absorption performance of 0.9 α_{Tmf} (e.g. Ecophon Akusto Wall C) ideally distributed evenly across rear wall (i.e. opposite the performance area) and one adjacent side wall if required.

9.3.2 Drama

In the Drama space, the BB93 reverberation time criteria is predicted to be achieved based on the following:

- Full suspended ceiling absorption (as per architect’s proposals) Ecophon Sombra, or equivalent.
- Wall panels: minimum 25m² wall panels providing minimum absorption performance of 0.9 α_{Tmf} (e.g. Ecophon Akusto Wall C), distributed evenly across a minimum of 2 non-parallel walls at low level (i.e. top of panels <3m AFFL).

9.3.3 Dining Hall

In the Dining Hall, acoustic modelling results indicate that the BB93 reverberation time criteria can be achieved based on the following current architectural proposals:

- Ceiling extent as indicated in architects ceiling finishes plans, as suspended ceiling, finish: Ecophon Gendina A or equivalent performance (suspended at 3.5m AFFL)
- Remaining soffit area finish: soffit suspended horizontal acoustic rafts, min. 89m² offering minimum absorption performance of 0.9 α_{Tmf} (e.g. Ecophon Solo rafts), assumed suspension maximum 3.25m AFFL.
- Wall panels: min. 66m² Acoustic wall panels providing minimum absorption performance of 0.9 α_{Tmf} (e.g. Ecophon Akusto Wall C); layouts as architects Draft acoustic panel setting out drawings.

Should the wall panel setting out change this should be reviewed for suitability by an acoustic consultant.

9.3.4 Sports Hall & Activity Studio

In the Sports Hall and Activity Studio, it is proposed to implement an absorption strategy in line with the BB93 Design Guide:

Figure 23: BB93 Example 'Acoustics of Schools: Design Guide' activity/sports hall absorption strategy

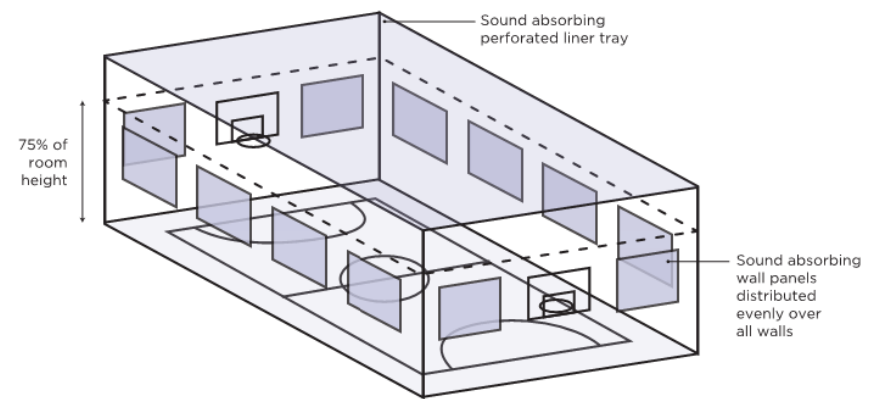


Figure A4.1 Example of sound absorbing finishes and even distribution of sound absorbing wall panels below 75 % of room height

9.3.4.1 Sports Hall

The following absorption strategy is recommended to meet the BB93 design guide requirements:

- Perforated metal roof-deck with mineral wool liner/profile inserts, provided to full soffit area, offering $\geq 0.6 \alpha_{tmf}$ performance, for example this level of performance can be achieved with a perforated D159 profiled deck with mineral wool inserts, or equivalent.
- Absorbent wall panels/system, at no greater than 75% height AFFL – It is recommended that the absorbent wall panels should provide $\geq 0.9 \alpha_{tmf}$ performance, cover a minimum of 125m² in the Sports Hall, and be distributed evenly across at least two non-parallel walls. For example, this level of performance could be achieved with an Ecophon Akusto Wall C wall panel.

9.3.4.2 Activity Studio

The following absorption strategy is recommended to meet the BB93 design guide requirements:

- Full available soffit coverage with suspended ceiling system offering $\geq 0.9 \alpha_{tmf}$ performance, e.g. Echophon Combison Duo A.
Note, the ceiling system in this area is required to provide a suitable level of flanking performance, refer Section 6.4.4.2 for further detail.
- Absorbent wall panels/system distributed at no greater than 75% height – It is recommended that the absorbent wall panels should provide $\geq 0.9 \alpha_{tmf}$ performance, cover a minimum of 39m² in the Activity Studio, and be distributed evenly across at least two non-parallel walls. For example, this

level of performance could be achieved with an Ecophon Akusto Wall C wall panel.

9.4 Circulation spaces providing direct access to teaching and learning areas

In corridors/circulation areas providing direct access to teaching and learning spaces, suspended ceiling it is recommended that a minimum of Class C acoustic ceiling tiles should be provided to the full ceiling area; it is understood that a Class A ceiling tile system (Ecophon Advantage A) is currently proposed, meeting the BB93/ADE criteria.

10 Building Services

10.1 Internal building services noise

Building service items and associated attenuation measures will be selected to ensure compliance with the BB93 IANL criteria.

The table below presents recommended building services noise upper limits to allow the BB93 IANL criteria to be achieved when considering the cumulative noise level of building services noise and other external noise sources (e.g. road traffic), and the BB93 mechanical services noise limits.

The upper limits are presented in terms of $L_{Aeq,T}$ dB and NR levels; both criteria should be complied with. The limits provided are cumulative and any selection should take account of the total number of noise sources within the space (e.g. inlet, outlet, case, number of units, etc)

Table 11: Proposed room-side building services noise limits

Room Type	Recommended building services noise limits to achieve the IANL criteria, $L_{Aeq, 30mins}$ dB	Recommended building services NR limits to achieve the IANL criteria
General Classrooms, Music Classrooms & Practice rooms	35	29
Offices, Staff workrooms, Meeting rooms, Interview room	40	34
SEN Group Rooms	30	24
SEN Therapy	35	29
Kitchen	50	44
Science Labs, RM workshops, Food, Art, ICT, Textiles, Graphics, Libraries & resource/breakout areas	40	34
Main Hall, Drama	35	29
Sports Hall, Activity Studio	40	34
Circulation spaces, corridors, stairwells	45	39
Toilets	50	44
Changing Rooms	50	44
Dining Room	45	39

10.2 Equipment noise levels

General comments on equipment selections with regard to noise levels are provided below:

- Primary attenuators should be incorporated into ductwork near to plant. This helps to reduce airborne noise transmission to the building to an acceptable level.
- In-room units located within occupied spaces will need to be carefully selected to ensure internal noise requirements are achieved. As well as in-line attenuation, it is important to recognise that the units may also need acoustic cladding / boxing in order to control the level of break-out noise from the unit casing. The requirement for this will be dependent on final unit selections.

It should be noted that the internal building services noise limits provided in are cumulative room-side limits, i.e. accounting for all sources of building services noise in the space (case radiated/breakout noise, and down-duct inlet & outlet noise).

During this design stage, preliminary equipment selections have been reviewed and comments provided to the engineers.

10.3 External plant noise emission limits

10.3.1 Plant noise limits at nearest noise sensitive receptors

External plant noise emissions associated with the development should be suitably controlled in order to maintain residential amenity at nearby noise sensitive receptors.

To inform a reasonable worst-case assessment it is assumed that plant associated with the proposed development is likely to be operational during the night time. Night time background levels have been established based on the feasibility survey data.

On this basis, the following cumulative noise limits (in terms of the BS 4142 defined Rating Level) are proposed for fixed items of plant associated with the development, in line with the Local Authority’s anticipated criteria.

Table 12: External plant noise emission limits

Noise sensitive receptor	Measured representative Background level, $L_{AF90,T}$ (dB)	Cumulative Plant Noise Rating Level Limit, $L_{Ar,Tr}$ (dB)
Residential dwellings off Mauldeth Road Daytime (0700-2300 hrs)	50	45
Residential dwellings off Mauldeth Road Night time (2300-0700 hrs)	40	35

Noise sensitive receptor	Measured representative Background level, $L_{AF90,T}$ (dB)	Cumulative Plant Noise Rating Level Limit, $L_{Ar,Tr}$ (dB)
Residential dwellings opposite the tram line Daytime (0700-2300 hrs)	44	39
Residential dwellings opposite the tram line Night time (2300-0700 hrs)	40	35

It should be noted that the plant noise limits provided are for the cumulative BS 4142 rating level of all items of plant, and allowance will be made for the number and noise character of the noise sources.

Plant noise will also be controlled sufficiently to ensure that the indoor ambient noise level design criteria are not exceeded.

It is assumed that air handling equipment will not be operational during the night time period.

A review of preliminary plant selections/data has been undertaken based on the roof plant layouts provided by the engineers. To allow the local authority’s noise criteria and the internal noise criteria associated with the CHSS development itself to be achieved the following preliminary noise limits are recommended to assist with equipment/attenuator selection,

- Equipment/attenuators should be selected to allow compliance with a proposed limit at atmospheric terminations of: Sound Pressure Level @ 1m ≤ 66 dBA;
- Roof mounted equipment (i.e. AHUs, extract fans) should be selected to allow compliance with a proposed case radiated noise limit of: Sound Pressure Level @ 1m ≤ 61 dBA.

Minor deviations from the above limit may be considered acceptable, and should be reviewed by an acoustic consultant.

The above is based on the equipment layouts provided (i.e. significant plant consisting of 2no. AHU, 3no extracts fans & 5no. condensers across the roof), and condenser noise levels of:

- OU01: 49-51dB SPL @1m;
- OU02: 44-46dB SPL @1m;
- OU03: 44-46dB SPL @1m;
- OU04: 49-51dB SPL @1m;
- OU05: 65-67dB SPL @1m.

During this design stage a review of preliminary plant noise data has been undertaken and recommendations have been provided to the project engineers as required.

10.4 Ductwork regenerated noise

Regenerated duct-borne noise is caused by the interaction of airflow with ductwork elements. The air speed within each system zone must be selected to limit regenerated noise levels. General comments on ductwork regenerated noise are provided below:

- The following table presents typical recommended velocities related to indoor ambient noise level criteria.

Table 13: Maximum recommended duct velocities

Room indoor ambient noise level criteria	In-duct max. air velocity (m/s)		
	Main	Branch	Final run-outs
≥31 dBA / NR 25	5	4.5	2.5
≥36 dBA / NR 30	6.5	5.5	3.25
≥41 dBA / NR 35	7.5	6.0	4.0
≥46 dBA / NR 40	9.0	7.0	5.0

- Dampers and other variable air devices such as VAV units can generate significant regenerated noise and may require acoustic lining or cladding to achieve building service noise criteria.
- Dampers near to supply termination elements should be set as near to the fully open condition as possible. In any case it should be ensured that the maximum permissible noise levels for each space are satisfied.
- Dampers should be installed at a suitable distance from other ductwork components and ductwork terminations including grilles and diffusers to prevent turbulent airflow and minimise regenerated noise.
- Ductwork layouts should incorporate the following (but not limited to) design principles to minimise regenerated noise and laminar airflow within the system:
 - Gradual bends.
 - Gradual changes in cross sectional area / long transition pieces.
 - Rectangular ductwork with a low aspect ratio.

Provide a minimum straight line of duct length equal to the height or width of the duct (whichever is greater) before and after duct bends, transitions, VAV units, attenuators including splitters/pods and any other duct elements which provide an equivalent or greater disruption to airflow.

10.5 Crosstalk noise transmission

Crosstalk noise transmission can occur between two spaces which are served by branches on a common duct system.

Sufficient crosstalk attenuation must be provided in order to achieve the internal sound insulation requirements between adjacent spaces and building service noise requirements specified in this report.

Ductwork should be acoustically lagged where necessary to limit flanking sound transmission to allow the sound insulation performance requirements to be achieved.

Crosstalks required in the following rooms/spaces where adjacent rooms are served by common duct system:

- General Classrooms
- Music Classrooms & Practice rooms
- Offices, Staff workrooms, Meeting rooms, Interview room
- SEN Resource, Group Rooms
- SEN Therapy
- Kitchen
- Science Labs, Food, Art, ICT, Textiles, Graphics, Libraries & resource/breakout areas
- RM workshops
- Main Hall, Drama
- Sports Hall, Activity Studio
- Dining Room
- Plant rooms

10.5.1 Acoustic lagging of ducts

Acoustic lagging should be provided from the crosstalk attenuator back to the separating partition/floor, provided the partition does not contain a door. (i.e. if the duct penetrates a wall with a door, no lagging required between wall and crosstalk)

A suitable specification would be 50mm acoustic lagging consisting of mineral wool incorporating a 5kg/m² mass layer.

In music spaces the above does not apply, i.e. ducts should be lagged from crosstalk to partition regardless of whether the partition has a door or not.

10.6 Common plenums

Ventilation plenums should be provided on a per room basis and should not run common between adjacent acoustically sensitive spaces.

10.7 Pipework

Where necessary, pipework must be suitably clad or lagged to prevent excessive pipe noise break-out and flanking sound transmission through pipes.

10.7.1 Drainage pipework

We recommend the following lagging strategy for drainage pipework passing through teaching, learning and study spaces.

- Lag with 50 mm thick proprietary acoustic lagging comprising of a mineral fibre core with 10 kg/m² outer mass barrier layer e.g. 50 mm H&H DuctiLag
- OR
- Enclose with a board material offering a minimum mass per unit area of 15 kg/m² and line the enclosure with 25 mm mineral wool (density range 10 – 90 kg/m³),

Should pressurised pipework layouts include large scale runs between occupied spaces, these runs may need to be acoustically lagged, particularly where partitions are specified with sound insulation ratings of >R_w 45 dB.

10.8 Vibration isolation

All vibration generating plant and machinery should be mounted on a heavy framework or floor slab and be supported by suitable anti-vibration mounts or resilient pads to prevent vibration energy transfer to the structure. If package units have integral isolation, direct mounting on housekeeping bases may be acceptable.

Flexible connections should be employed between isolated plant and non-isolated components and building elements. These connections should allow unrestricted movement of the plant item and should not make up for misalignment.

11 Summary

Acoustic design performance standards have been detailed for the various room types included within the proposed Chorlton High School South development in accordance with BB93 and other relevant guidance documents.

A summary of the environmental noise survey and noise prediction modelling has been provided.

Recommendations with regard to the acoustic performance of building envelope elements have been provided.

Partition and door sound insulation ratings have been provided for floorplans; a review of the architects proposed partition layout plans has been undertaken.

Airborne and impact sound insulation of floors has been assessed, with recommendations for improvement of impact sound insulation where required.

General detailing principles to maintain sound separation standards between typical adjacent spaces have been provided, along with a number of detail reviews including head deflections, penetration, and steel beam enclosure details.

Acoustic absorptive finish recommendations for accommodation across the scheme have been provided on the basis of the architects preliminary ceiling finish proposals, and the results of acoustic calculations and 3D modelling.

Internal and external building services noise limits have been provided to allow the relevant design criteria to be achieved.

Appendix I – Glossary of Acoustic Terms

Acoustic Absorption

Acoustic absorption refers to the process by which energy is removed from the sound field. Most materials will absorb a proportion of sound, i.e. convert acoustic energy into heat. It is measurable and is defined for any particular material or surface by a coefficient α between 0 (totally reflective) and 1 (totally absorbent) at each frequency. Acoustic absorption is defined as the product of the surface area of the absorbing material (S), and its absorption coefficient (α).

A-Weighting

Normal hearing covers the frequency range from about 20Hz to 20kHz but sensitivity is greatest between about 500Hz and 8kHz. The "A-Weighting" is an electronic filters network incorporated in sound level meters which approximately corresponds to the frequency response of the ear. The unit of measurement of A-weighted sound level is dBA.

Decibel, dB

This is the unit to measure sound. The human ear has an approximately logarithmic response to acoustic pressure over a very large dynamic range (typically 20 micro-Pascals to 100 Pascals). We therefore use a logarithmic scale to describe sound pressure level, intensities and sound power levels. Subjectively, an increase of 10 dB corresponds to a doubling in the perceived loudness of sound.

Equivalent Continuous Sound Level L_{eq} or L_{Aeq}

The continuous equivalent sound level, L_{Aeq} is a notional sound level. It is the sound level, which, if maintained for a given length of time, would produce the same acoustic energy as a fluctuating noise over the same time period. (The above formula is implemented electronically in all good sound level meters and it is customary to measure rather than calculate the equivalent continuous sound level.) L_{Aeq} is widely used to measure any environmental noise which varies considerably with time.

Flanking Transmission

Sound transmitted between rooms via flanking elements instead of directly through separating elements or along any path other than the direct path.

Mid-Frequency Reverberation Time, T_{mf}

The arithmetic average of reverberation times in the 500Hz, 1kHz and 2kHz octave bands.

Octave and Third Octave Bands

The human ear is sensitive to sound over a range of approximately 20Hz to 20kHz, and is generally more sensitive to medium and high frequencies than to low frequencies. In order to define the frequency content of a noise, the spectrum is divided into frequency bands, and the sound pressure level is measured in each band. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. (For instance the octave bands above and below the 500Hz octave band are 1kHz and 250Hz respectively). For finer analysis, each octave band may be split into three one-third octave bands or in some cases, fine frequency bands.

Reverberation Time, RT

The RT is defined as the time taken for an impulsive sound to die away to one thousandth of its original sound pressure level - that is, to decrease by 60dB. The sound waves are reflected many times from each surface in the room, and are partly reduced at each reflection, the amount of reduction depending on the acoustic absorption of the surface. Acoustic absorption is measurable and is defined by a coefficient between 0 (totally reflective) and 1 (totally absorbent) at each frequency. Although an anomaly in the standard laboratory test procedure can lead to absorption coefficients higher than 1, this is not achievable in real installations.

Statistical Level L_{90} or L_{A90}

Sound pressure level that is exceed for 90% of the measurement time. Consequently it is indicative of the general background noise level in the absence of any higher level short duration events that occur during the period.

Weighted element normalized level difference $D_{n,e,w}$

The single number quantity for difference in the space and time averaged sound pressure level produced in two rooms by a source in one, where sound transmission is only due to a small building element (e.g. transfer air devices, electrical cable ducts, transit sealing systems). The $D_{n,e,w}$ relates to the value, in decibels, of the reference curve at 500Hz after shifting it in accordance with the method specified in ISO 717-1.

Weighted Sound Reduction Index, R_w

This is a weighted single figure descriptor of the sound insulation performance of a partition measured under laboratory conditions. The sound reduction index in each of the one-third octave bands from 100Hz to 3150Hz is compared with a standard set of curves. The value of R_w for a given partition is obtained from the standard curve which when compared with the measured SRI values produces an adverse deviation as close to -32dB as possible. Only the SRI values which fall below a particular standard curve are considered in the sum. Positive deviations from the standard curve are not taken into account.

Weighted Standardised Level Difference, $D_{nT,w}$

The single number quantity for airborne sound insulation rating, relating to the value, in decibels, of the reference curve at 500Hz after shifting it in accordance with the method specified in ISO 717-1: 1997.

Weighted Standardised Impact Sound Pressure Level, $L'_{nT,w}$

Weighted standardised level, a single figure generated by comparing the L'_{nT} with the reference curve at 500 Hz after shifting it in accordance with the method specified in BS EN ISO 717-2: 1997. The reference curve is shifted in 1 dB steps until the sum of adverse deviation of the test curve, compared to the reference curve, is as large as possible, but no more than 32.0 dB. The value of the shifted reference curve at 500 Hz is taken as the $L'_{nT,w}$. N.B. As $L'_{nT,w}$ for impact transmission represents an absolute level, a lower figure constitutes better performance.

Appendix II – Summary of BB93 February 2015 ventilation condition, system type and associated IANL tolerance

Table 14: Summary of ventilation condition, system type and associated IANL tolerance (reproduced from BB93, Table 2)

Condition	Ventilation system	Noise level limit
Normal - ventilation for normal teaching and learning activities	Mechanical ¹	Table 1 value
	Natural ²	Table 1 value + 5 dB ⁴
	Hybrid ²	Mechanical system noise: Table 1 value
		Total noise level: Table 1 value + 5 dB
Summertime ⁵ - ventilation under local control of teacher to prevent overheating – allowable during the hottest 200 hrs of the year	Mechanical	Table 1 value + 5 dB ⁴
	Natural or Hybrid	≤55 dB
Intermittent boost ⁶ – ventilation under local control of teacher for dilution of fumes during practical activities as in practical spaces for science, art, food technology and design and technology	Mechanical	Table 1 value + 5 dB ⁴
	Natural	≤55 dB
Process – extract ³ can be automatic ventilation for safety and/or under local control of teacher	Mechanical and/or natural	See IoA/ANC guide for operational noise levels

¹ The normal condition for a ventilation system with purely mechanical air supply is defined as when the system is operating to limit the daily average carbon dioxide concentration to no more than 1,000ppm with the maximum concentration not exceeding 1,500ppm for more than 20 consecutive minutes on any day during normal school operating hours. This would normally equate to a minimum ventilation rate of approximately 8l/s per person. Mechanical ventilation in this context refers to systems (or parts of systems) that use mechanical fans to mix or drive the air including those in mechanical, hybrid, mixed mode and natural ventilation systems and in fan convector heaters.

² The normal condition for a ventilation system in natural or hybrid mode is defined as when the system is operating to limit the daily average carbon dioxide concentration to no more than 1,500ppm with the maximum concentration not exceeding 2,000ppm for more than 20 consecutive minutes on any day. This would normally equate to a minimum ventilation rate of approximately 5l/s per person. For hybrid systems, the mechanical noise excluding external noise break in, should meet the IANL figure in Table 1.

The mid-season design condition can be used in simple ventilation calculations and is defined as an outside temperature of 11 °C and an internal air temperature of 20 °C with no external wind effect.

Where there is a hybrid system, any mechanical system components should meet the IANL limits from Table 1. The total noise level including external noise ingress may exceed the IANL limit from Table 1 by up to 5 dB.

³ Process extract includes the operational noise from local exhaust ventilation systems and boost ventilation under the local control of the teacher as required for fume and dust extract in

design and technology, odour and steam from cookers in food technology, fume cupboard extract and similar process extract systems. See guidance on specification and measurement of operational noise levels in 'Acoustics of Schools: a design guide'

⁴ The +5 dB does not apply to teaching and learning spaces where the Table 1 IANL is greater than or equal to 45 dB.

⁵ Natural, mechanical or hybrid ventilation systems may be used to improve thermal comfort in summer at the expense of higher IANL. The normal ventilation IANL can be exceeded during the hottest 200 hours in peak summertime conditions and the design should show that IANLs, defined in the table above can be met under these conditions as well as under normal operation. The ventilation must be under the local control of the teacher so that the noise level can be reduced to normal levels when needed. This does not apply to classrooms intended specifically for students with special hearing and communication needs, or to speech therapy rooms.

The peak summertime condition is defined as the 200 hottest hours that occur using the design summer year (DSY) weather file during normal daily school operating hours including the summer holiday period. Thermal modelling and assessment of acoustic performance should be carried out as if the school were occupied through the summer holiday period. This corresponds to a much lower number of hours during normal term time (equivalent to typically 40 teaching hours in a school year) as most of the hottest hours occur during the holiday period.

⁶ The noise level from locally controlled intermittent boost mechanical ventilation may exceed the IANL by up to 5 dB.