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School Acoustics Report

BB93 & BREEAM HEA5 Assessment

21st May 2021

Proposal Number:	21058-2-R1
Client:	Melin Consultants
Site Address:	Ysgol Treferthyr Criccieth

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UKAS TESTING 2694

Report Number	21058- 2-R1
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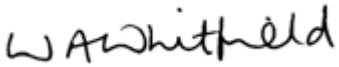
Prepared	21st May 2021
Prepared By	 Bill Whitfield PhD, MSc, MIOA
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3. Contents

4. Introduction

noise.co.uk Ltd has been appointed by Melin Consultants to carry out an assessment of the architectural and design proposals for the proposed new Ysgol Treferthyr (hereafter referred to as "the School"). The location and general layout of the School is illustrated in Figure 1.

The School is required to comply with Building Bulletin 93[1] ("BB93") 'Acoustic design of schools: Performance Standards' published in February 2015. BB93 applies to all areas of a school. Criteria given for teaching and learning spaces are mandatory requirements. Recommendations for administration and ancillary areas are for guidance only.

Although the School is required to comply with BB93, there may be some areas where this is not practicable or advantageous. In these instances, an Alternative Performance Standard (APS), as permitted by Section 0.5 of BB93, will be suggested and best efforts should be made to satisfy the operational requirements of the situation alongside providing the best practicable levels of acoustic control.

This report outlines the acoustic strategy that is being adopted for the School and suggests several design and construction solutions to accompany this strategy. It is expected that this report will be reviewed and updated during the design process, in accordance with the development of the scheme. Much of the design guidance has been taken from 'Acoustics of Schools: A Design Guide' (Design Guide).

4.1. Content

This report covers the following criteria, as required within BB93:

- Internal ambient noise levels within the school
- Sound insulation/transmission between adjacent teaching spaces
- Control of rain noise
- Reverberation control within spaces

This report has been based on design drawings received for the School at the date of issue of this report.

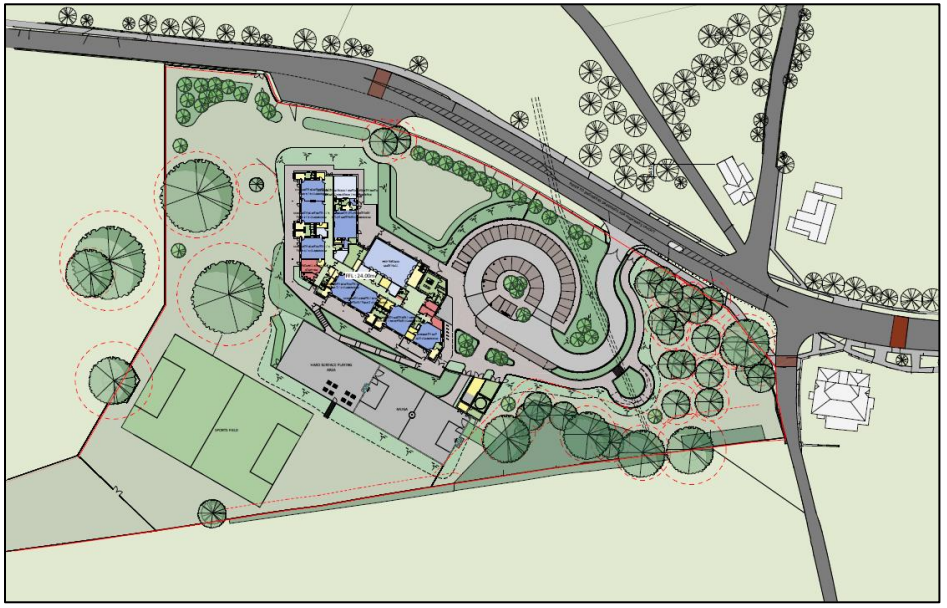


Figure 1 – Location and layout of the Proposed Development

[1] Building Bulletin 93: Acoustic Design of Schools – Performance Standards, February 2015

4.2. BREEAM New Construction 2018

BREEAM is a sustainability rating scheme that aims to mitigate the life-cycle impacts of buildings on the environment and provide a credible way to rate and label them. The rating system is comprised of a number of credits which span the range of issues that affect the environmental impact of a building including: management, health and wellbeing, energy, transport, water, materials, waste, land use and ecology, pollution and innovation.

Within the range of issues there are two credit issues that have implications to noise and buildings: HEA05 Acoustics and POL 05 Reduction of Noise Pollution.

i. HEA05: Acoustics

Noise within buildings can come from various sources, including building services, occupants, equipment and external sources. Excessive noise can have a range of adverse effects in education establishments including inconvenience and annoyance, loss of concentration and decreased productivity. Therefore, the management of noise within education establishments is important to maximise occupant comfort, occupant efficiency and to provide privacy. As a result, building acoustics are an important consideration in the design, operation and construction of education establishments. Building acoustics should allow rooms to be used as intended, without compromising sound-sensitive spaces or activities.

For education establishments, up to three credits are available in the HEA05 issue:

- **Credit 1:** Sound insulation
- **Credit 2:** Indoor ambient noise level
- **Credit 3:** Room acoustics.

For credits 1-3, the performance standards set out in Section 1 of Building Bulletin 93 (''BB93'') should be met and a programme of commissioning tests should be carried out in accordance with ANC guidance[2] to demonstrate the performance at post-construction stage.

4.3. Consultant's Qualifications

The person responsible for this report is Bill Whitfield. He holds a Masters degree in Environmental Engineering and a PhD in Acoustics from the University of Liverpool and has more than 30 years experience in acoustics and is a full corporate member of the Institute of Acoustics.

[2] ANC Good Practice Guide: Acoustic Testing of Schools, Version 2, November 2015

5. Airborne Sound Insulation

5.1. Target Criteria

i. Airborne Sound Insulation Between Adjacent Rooms

BB93 gives criteria for the sound insulation performance of dividing elements between adjacent rooms (non-circulation spaces), based on the activity noise level and tolerance to noise created within adjacent areas.

Table 1 shows the required airborne sound insulation performance for partitions between areas of differing activity noise levels and tolerances.

Airborne sound insulation performance of partitions (dB $D_{nT,w}$)		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

Table 1 – Performance standards for new build and for airborne sound insulation between spaces

The sound insulation performance values are quoted as the minimum weighted BB93 standardised level difference, $D_{nT,w}$, a site-tested value. Manufacturers normally quote the sound insulation performance of their systems as a laboratory tested R_w value. $D_{nT,w}$ includes the effect of any glazing, doors, and other weaknesses in the partition. For sound insulation values above 35 dB $D_{nT,w}$, normal (non-acoustic) doors will greatly impair the sound insulation performance of the partition.

The reference reverberation time T for calculation purposes may either be the upper design limit for mid-frequency reverberation time or the measured in-situ reverberation time in the finished and 'normally' furnished room.

ii. Airborne Transmission Between Circulation and Other Spaces

BB93 specifies criteria for the sound insulation performance of new dividing elements between circulation (e.g. corridor) and other spaces.

Table 2 shows the composite airborne sound insulation performance required for partitions and doorsets for corridor walls to different types of spaces used by students in the School. These criteria take the form of laboratory ratings, R_w.

Type of space used by students	Minimum R_w dB	
	Composite R_w of wall and glazing with no ventilator	Doorset
Multi-purpose hall Teaching space intended specifically for use by students with special hearing and communication needs	45	35
All other rooms used for teaching and learning	40	30

Table 2 – Performance standards for airborne sound insulation between circulation spaces and other spaces used by students with no ventilator in the wall

Where the composite R_w of the wall, glazing and doors is specified as per Table 2, the minimum ventilator sound reduction can be specified as per Table 3, if required.

Type of space used by students	Minimum ventilator $D_{n,e,w}$ – 10log(N) dB
Multi-purpose hall Teaching space intended specifically for use by students with special hearing and communication needs	37
All other rooms used for teaching and learning	32

Table 3 – Minimum ventilator sound reduction specification for walls, glazing and doors that meet the specification from Table 2. N is the number of ventilators in the wall

The attenuating performance of ventilators is quoted in terms of the minimum weighted element normalised level difference $D_{n,e,w}$. Where multiple ventilators are used, the $D_{n,e,w}$ of each ventilator must be corrected to allow for the increase in the number of units.

5.2. Design Specifications

An assessment of the required sound insulation of each dividing element within the proposed development has been made. In accordance with BB93, the performance for airborne sound insulation has been considered in both directions and the most stringent requirement indicated.

The following sub-sections give suggested constructions and detail performance requirements for new dividing walls within the proposed development in order that BB93 requirements can be met. However, suitable acoustic detailing and quality of workmanship on site will be needed to see that the expected performance is realised.

Specifications are based on partitions being full height from structural floor to soffit with no penetrations for glazing or ventilation within the dividing element, except where stated. Should there be a requirement for glazing or high-level ventilation, performance requirements may need to be adjusted accordingly.

The following constructions are therefore recommended, with efforts being made wherever possible to rationalise constructions, whilst considering robustness.

The sound insulation performance values are quoted as the minimum weighted BB93 standardised level difference, $D_{nT,w}$, a site-tested value where T is the mid-frequency reverberation time, $T_{mf,max}$. Manufacturers normally quote the sound insulation performance of their systems as a laboratory-tested R_w value. Guidance on partition specification has been taken from the Design Guide but a minimum uplift of 7dB has been allowed between $D_{nT,w}$ and R_w in accordance with manufacturer's recommendations.[3] Performance figures have been taken from the British Gypsum White Book and The Design Guide and have been summarised in Table 4.

i. General Partition Guidelines

To see that acoustic integrity and performance of partitions is maintained and controlled, the following guidance is suggested:

- All partitions should be full height; from the structural floor to the underside of the soffit or roof support structure and well-sealed. If the floors are insulated, it should be broken at the interface with the partition.
- Electrical switch sockets should not be placed back-to-back within lightweight partitions, but spaced a minimum 150 mm apart.
- Electrical sockets located in lightweight partitions having a sound insulation performance requirement of $D_{nT,,w}$ 40dB or greater should be specified with appropriate proprietary socket box covers/infills. Hilti Putty Pads, Firefly Socket Box Covers, or Knauf Putty Pads would be considered appropriate products.
- Services penetrating acoustically rated partitions which divide adjacent noise sensitive spaces should be avoided, particularly ductwork. Ideally, service runs would be via the corridor, with branches spurring off the main runs into rooms via the corridor walls. Where penetrations through acoustically-rated walls cannot be avoided. A full schedule of service penetrations has been provided in the appendix.
- Where double layers of board are used, joints should be staggered.
- Where a partition rated at $D_{nT,w}$ 40 dB or greater abuts the internal board lining of the external wall, the board lining would need to be broken at the junction with the partition, with a mineral fibre cavity closer used at these junctions. The inner board lining of external walls should comprise of

[3] British Gypsum White Book, 12th Edition, Saint-Gobain, Page 22

minimum two layers of 12.5mm SoundBloc. A suitable example construction detail has been provided in the appendix.

- Where partitions abut blockwork walls that are common between the two rooms separated by the partition (e.g. a blockwork external inner leaf), the other flanking walls should be specified to the same mass and surface finish to avoid excessive flanking transmission. Alternatively, independent plasterboard wall linings can be fitted to the room face of the flanking wall.
- Where adjacent noise-sensitive rooms (i.e. teaching areas or private offices) are served by a common ventilation duct, crosstalk attenuators will be required.
- Ductwork passing from any non-circulation space through a noise-sensitive room (without serving that room), should be lagged with 15 mm Muftilag P.
- Where partitions are sealed to the underside of a profiled liner sheet, dense mineral fibre infill pieces should be trapped in the profiles by a layer of plasterboard spanning across the profiles and partition head. Each side of the boarding should then be well sealed to the plasterboard. An example construction detail has been provided in the appendix.
- Where ribbed floor or deck profiles run perpendicular to partitions, plasterboard should be scribe-cut to match the profile, fixed to the head of the partitions and well sealed into the profiles using a continuous bead of non-hardening mastic. An example construction detail has been provided in the appendix.

5.3. Isolation of Steelwork

Consideration will need to be given to the treatment of structural steelwork to minimise noise transfer between noise-sensitive spaces. No structural steelwork should be left exposed, unless the steel is fully isolated from other steel members that connect to student or ancillary spaces, or unless hollow steels are filled with concrete.

Where steel beams are concealed within ceilings, care should be taken to see there is no hard contact between steelwork and ceiling.

Wherever possible, structural steelwork and bracing should be incorporated within partitions/floors. Where structural steelwork crosses partitions dividing noise-sensitive spaces, these may need to be boxed out in plasterboard to prevent structure-borne noise transfer.

It is recommended that any suspended equipment (such as drop rods for lighting rigs, loudspeaker fixings, and other specialist items) be fixed to steelwork via suitable resilient mountings or hangers.

5.4. SVP

Where SVP/RWPs run within student or noise-sensitive ancillary spaces, they should be lagged using 25 mm unfaced mineral wool, strapped in place, and boxed out with an enclosure having a mass per unit area of at least 15 kgm^{-2} in accordance with guidance given in Approved Document E. Boarding should be mounted on a frame in no hard contact with the SVP/RWP. Suitable boarding would be two layers of 12.5 mm plasterboard. Boarding should be full height, taken up to the soffit, and sealed at top and bottom using a bead of non-hardening sealant.

Should SVP/RWPs run horizontally through ceiling voids, it is considered that an enclosure comprising 1 layer of 12.5 mm wallboard would be sufficient (i.e. the ceiling providing the additional attenuation). Such SVP/RWPs would still require lagging strapped in place, as above.

Syphonic draining systems can generate significantly higher noise levels than standard gravity RWP systems, and therefore it is recommended that two layers of 15 mm SoundBloc or equivalent, would be required in conjunction with the lagging.

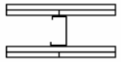
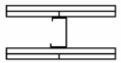
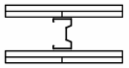
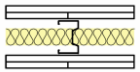
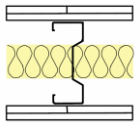
Key	Description	Illustration	Manufacturer Rating	Acoustic Requirement
CYAN	2 x 12.5mm Gyproc WallBoard 48mm Gypframe metal C stud 2 x 12.5mm Gyproc WallBoard		(A206003) 42dB R_w	40dB R_w
	100mm block Density 140kg/m^2 Plastered/rendered 12mm on one side		40-45dB R_w	
BLUE	2 x 12.5mm Gyproc SoundBloc 48mm Gypframe metal C stud 2 x 12.5mm Gyproc SoundBloc		(A206154) 46dB R_w	45dB R_w
	100mm block Density 140kg/m^2 Plastered/rendered 12mm on both sides		45-50dB R_w	
YELLOW	2 x 12.5mm Gyproc SoundBloc 70mm Gypframe AcuStud 2 x 12.5mm Gyproc SoundBloc		(A206A166) 53dB R_w	≤52dB R_w
	215mm block Density 430kg/m^2 Plastered/rendered 12mm on both sides		50-55dB R_w	
GREEN	2 x 12.5mm Gyproc SoundBloc 70mm Gypframe AcuStud 25mm Isover Acoustic Roll 2 x 12.5mm Gyproc SoundBloc		(A206A198) 58dB R_w	≤57dB R_w
	100mm block Density 140kg/m^2 Plastered/rendered 12mm on both sides British Gypsum Gyplyner Universal with 1x12.5mm SoundBloc, 35mm cavity and 25mm Isover APR 1200	/	(B226008) 57dB R_w	
RED	2 x 15mm Gyproc SoundBloc + Plaster Skim 146mm Gypframe AcuStud 50mm Isover Acoustic Roll 2 x 15mm Gyproc SoundBloc + Plaster Skim		(A206A243S) 62dB R_w	≤62dB R_w
	100mm block Density 140kg/m^2 Plastered/rendered 12mm on both sides British Gypsum Gyplyner Universal with 1x12.5mm SoundBloc, 85mm cavity and 50mm Isover APR 1200	/	(B226007) 64dB R_w	

Table 4 – Example constructions that would be suitable for use on the school. Please refer to the marked-up plan in the appendix.

5.5. Plant Rooms

i. Noise from Plant Rooms

The plant rooms have been classified as having a 'Very High' activity noise level for the purposes of specifying the required sound insulation. It is possible that, when the exact items of plant have been chosen, and their sound power levels confirmed, that these specifications could be reduced. The specifications for the dividing walls and floors of the plant rooms have been given in Table 5.

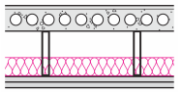
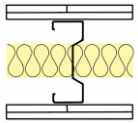
Key	Description	Illustration	Typical Performance
First Floor Construction	30-50mm screed and precast concrete plank with combined mass per unit area 100kg/m², Suspended plasterboard ceiling consisting of 2 layers of 12.5mm plasterboard with 100mm of mineral wool in a 240mm void.		60-65dB R_w
Plant Room Wall RED	2 x 15mm Gyproc SoundBloc + Plaster Skim 146mm Gypframe AcuStud 50mm Isover Acoustic Roll 2 x 15mm Gyproc SoundBloc + Plaster Skim		(A206A243S) 62dB R_w
	100mm block density 140kg/m² Plastered/rendered 12mm on both sides British Gypsum Gyplyner Universal with 1x12.5mm SoundBloc, 85mm cavity and 50mm Isover APR 1200	/	(B226007) 64dB R_w

Table 5 – Example constructions for walls and floors to the plant room

ii. Plant Vibration

All items of mechanical plant should be fitted with appropriate vibration isolation measures, selected specifically for the point loading and speed of moving parts within the item of plant. All anti-vibration mounts shall have a minimum deflection of 25 mm and provide at least 95% efficiency. Appropriate finishes shall be applied to prevent excessive corrosion where atmospheric or internal conditions would be detrimental to the isolator material.

5.6. Doors and Internal Glazing

i. Internal Doors

Doors dividing ordinary teaching spaces and common/circulation spaces require proprietary acoustic doorsets capable of achieving a minimum sound reduction of R_w 30dB. Doors dividing SEN rooms or the multi-purpose hall and common/circulation spaces require proprietary acoustic doorsets capable of achieving a minimum sound reduction of R_w 35dB. An exception has been made for the School for the main hall because lobbied doors have been accommodated in the design. Recommended door specifications are given in Table 6 below.

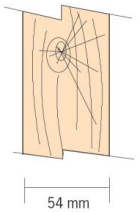
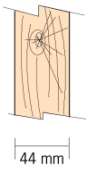
Element	Illustration	Description
Doors between teaching spaces. Doors between music or SEN rooms and circulation spaces.		54mm FD60 solid timber door with compression or wipe seals. Threshold seals required. (35dB R_w)
Doors between normal teaching spaces and circulation spaces.		44mm FD30 doors with compression or wipe seals. Threshold seals required. (30dB R_w)

Table 6 – Recommended door specifications

All acoustic doorsets should be of proprietary type, by a specialist manufacturer. The acoustic rating of the doorset should include the door, frame, seals and hinges. For other doorsets, dividing ancillary spaces to common circulation areas there is no specific requirement for acoustic insulation; however, it is recommended that in particularly noise sensitive locations, such as private offices, proprietary acoustic doorsets capable of achieving a minimum sound reduction of R_w 30 dB should be specified.

The drawings reference provided in the appendix indicate doorsets that have an acoustic rating. To minimise flanking noise between adjacent spaces, it is also recommended that doorsets be spaced as far apart as is practical.

ii. Interconnecting Doorsets

Where pairs of teaching spaces are linked via an interconnecting door for operational reasons, BB93 requires the provision of a minimum R_w 35dB doorset within a wall with a minimum composite rating of R_w 45dB. This occurs between a number classrooms.

iii. Glazed Screens

If glazed screens are to be located to the side of doors and would be considered a part of the doorset itself, these screens should have the same rating as the associated door, i.e. R_w 30/35dB depending on the door specification.

Where glazed screens are located within partitions dividing teaching spaces from circulation spaces, the partition as a whole must achieve a certain composite performance (i.e. the aggregate performance of the glazed element, plus the solid element if present).

Recommended internal glazing specifications are given in Table 6.

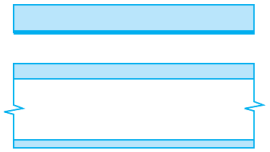
Element	Illustration	Description
Vision panels that are part of the doorset		
Glazed screens immediately adjacent to doors which divide standard teaching spaces from circulation spaces		10mm single float glass
Glazed screens immediately adjacent to doors which divide music/drama/SEN/SLCN /multi-purpose hall spaces from circulation spaces		10mm laminated single float glass
Glazed screens within partitions to corridors		
Typically this will be R_w 40dB for standard teaching spaces		19mm laminated single float 10mm glass/50mm air/6mm glass
Typically this will be R_w 45dB for music/drama/SEN/SLCN /multi-purpose hall spaces		17mm laminated glass/12mm air gap/10mm glass

Table 7 – Recommended internal specifications[4]

5.7. Canteen Serving Hatch

Serving hatches should have a sound reduction index of not less than 18 dB R_w. The plans currently show a lobbied arrangement for storing the dining tables and chairs which will also be very effective. The lobby should be fitted with 35dB R_w doors minimise noise breakout from the kitchen to the Main Hall.

[4] Acoustics of Schools: A Design Guide, November 2015, Figure 3.9

6. Indoor Ambient Noise Limits

6.1. Target Criteria

BB93 provides indoor ambient noise level (IANL) criteria for all teaching and student spaces, based upon the use of each space. Noise from mechanical services and noise ingress through the façade must not exceed this noise level, specified in terms of dB $L_{Aeq,30mins}$. Table 8 below shows the BB93 upper limit for IANLs for the areas present in the school.

Type of space used by students	Upper limit for indoor ambient noise level, dB $L_{Aeq,30mins}$
	New-build
Music ensemble room, teaching spaces for pupils with special hearing and communication needs	30
Nursery school classroom Primary school: - Classroom - Small group room - Multi-purpose hall	35
General offices Staff room Head teacher's office Design and technology/art room	40
Corridors and stairwells. Coats and locker areas	45
Changing areas, toilets, kitchens	50

Table 8 – BB93 upper limit for ambient noise levels

In order to protect students from regular discrete noise events, e.g. aircraft or trains, indoor ambient noise levels should not regularly exceed 60dB $L_{A1,30mins}$. This is achieved by default for spaces with IANLs upto 40dB $L_{Aeq,30min}$, but requires assessment in spaces with high IANL limits, e.g. 45 and 50dB.

Ventilation Requirements

The 'normal' condition for a natural ventilation system is defined as when the system is operating to limit the daily carbon dioxide concentration to 1500ppm with the maximum concentration not exceeding 2000ppm for more than 20 minutes.

The following exceptions apply to the IANL criteria where a hybrid system or purge ventilation:

- Where normal ventilation is provided by mechanical services, the IANLs should meet the criteria from Table 8.
- Where rooms are naturally ventilated a 5dB relaxation of the criteria in Table 8 is permitted.
- Where a hybrid ventilation system is specified (providing 5 l/s per person in the room) a relaxation of 5dB is permitted for the combined noise level resulting from mechanical ventilation and external noise sources. The noise from mechanical ventilation alone should meet the criteria from Table 8.

During the hottest 200 hours of the year (during typical school hours but also including summer holidays), it is acceptable for ventilation to be under the local control of the teacher. Where intermittent boost or summertime functions are provided for, the following guidance should be followed:

- A user controlled mechanical ventilation boost function for summertime conditions or purge ventilation also a 5dB relaxation the values stated in Table 8.
- Where natural ventilation provides the intermittent boost function, the IANLs due to external noise sources should not exceed 55dB

6.2. Survey

i. Measurement Instrumentation

The measurement instrumentation used during the survey is detailed in the appendix. The acoustic equipment was calibrated to comply with Section 4.2 of BS7445-1:2003 before and after the surveys. The calibration details can also be found in the appendix.

ii. Monitoring Locations

Monitoring was carried out at two locations to account for the dominant local noise sources. This is illustrated in Figure 2.

Figure 2 – Plan showing the location of the monitoring equipment

The monitoring equipment was located 1.5m from the ground and at least 3m from the next nearest reflecting surface.

iii. Measurement and Timescale

Unattended noise monitoring took place over a typical weekday period between Wednesday 14th October 2020 and Thursday 15th October 2020. The following quantities were measured:

$L_{Aeq,30\text{-}min}$

The acoustic measurements and their interpretation have been in accordance with BS 7445: Parts 1, and 2. All sound pressure levels are in dB (re 20μPa).

iv. Meteorology

During the survey the weather information was noted. This is shown in Table 9.

	Wednesday 14th October 2020	Thursday 15th October 2020
Roads(Wet/Dry)	Dry	Dry
Wind Speed (ms^{-1}) / Direction	5 SW	4 SW

Table 9 - Meteorological data noted during the survey

6.3. Measurement Results

The measured sound pressure levels have been used to calculate the worst-case half-hourly sound pressure level between 09:00-17:00. The results have been summarised in Table 10.

	Position 1	Position 2
Worst-case $L_{Aeq,30\text{-}min(09:00\text{-}17:00)}$	70.6	61.2

Table 10 – Summary of the key measurement results

6.4. Design Specifications

The indoor ambient noise level will include contributions from:

1. external environmental noise sources; and,
2. noise from mechanical services.

It has been assumed that there would be a 50% contribution from each of these sources to the overall level.

Based on the measured free-field sound pressure levels, the simple calculation method from BS8233:2014[5] has been used to determine the necessary sound reduction to meet the indoor ambient noise level criteria from BB93. A typical blockwork external wall construction has been assumed such that the glazing is likely to be the lowest performing facade element. The recommended glazing configuration has been detailed in Table 11 and the locations where they apply in Figure 3.

Noise rating (NR) is a graphical method for assigning a single-number rating to a noise spectrum. It can be used to specify the maximum acceptable level in each octave band of a frequency spectrum or to assess the acceptability level in each octave band of a frequency spectrum. The NR of a spectrum corresponds to the value of the first NR contour that is entirely above the spectrum. Table 11 gives suggested NR levels for mechanical services noise in the variety of rooms expected within the development. NR values cannot be converted directly to dB(A) values but the suggested NR levels are based on an approximate relationship.[6] These values reflect the mechanical ventilation system noise during normal use.

7. Rain Noise

Although rain noise is excluded from the definition of indoor ambient noise in BB93, Building Regulation submissions should demonstrate that lightweight roofs and roof glazing have been designed to provide suitable control of rain noise reverberant sound pressure level in a space.

High levels of rain noise can arise in spaces such as sports halls and assembly halls where the roof has a large surface area comprising profiled metal cladding with no suspended ceiling to attenuate the noise before it radiates into the space below. The following treatments can be combined to provide control impact noise from rainfall:

- damping of the profiled metal cladding;
- use of dense mineral wool insulation in the roof build-up; and,
- independent ceilings below the lightweight roof.

If a profiled metal cladding roof were used without any of these treatments, it is unlikely to provide sufficient resistance to impact sound from rain on the roof.

[5] BS8233: 2014 "Guidance on Sound Insulation and Noise Reduction for Buildings"

[6] *BS8233:2014, Annex B*

Type of space used by students	Upper Noise Rating for Mechanical Services	Glazing Specification	
		Specification 1	Specification 2
Teaching spaces for pupils with special hearing and communication needs	NR21	Min 4(12)4 standard thermal double glazing	/
Nursery school classroom Primary school: - Classroom - Small group room - Multi-purpose hall	NR26	Min 4(12)4 standard thermal double glazing	≥ 33dB R_w+C_{tr} 6(12)10 double glazing
General offices Staff room Head teacher's office Design and technology/art room	NR31	Min 4(12)4 standard thermal double glazing	≥ 27dB R_w+C_{tr} 6(12)6 double glazing
Corridors and stairwells. Coats and locker areas	NR36	Min 4(12)4 standard thermal double glazing	≥ 22dB R_w+C_{tr} 4(12)4 standard thermal double glazing
Changing areas, toilets, kitchens	NR41	Min 4(12)4 standard thermal double glazing	Min 4(12)4 standard thermal double glazing

Table 11 – Recommended upper limits for ventilation systems and glazing specifications

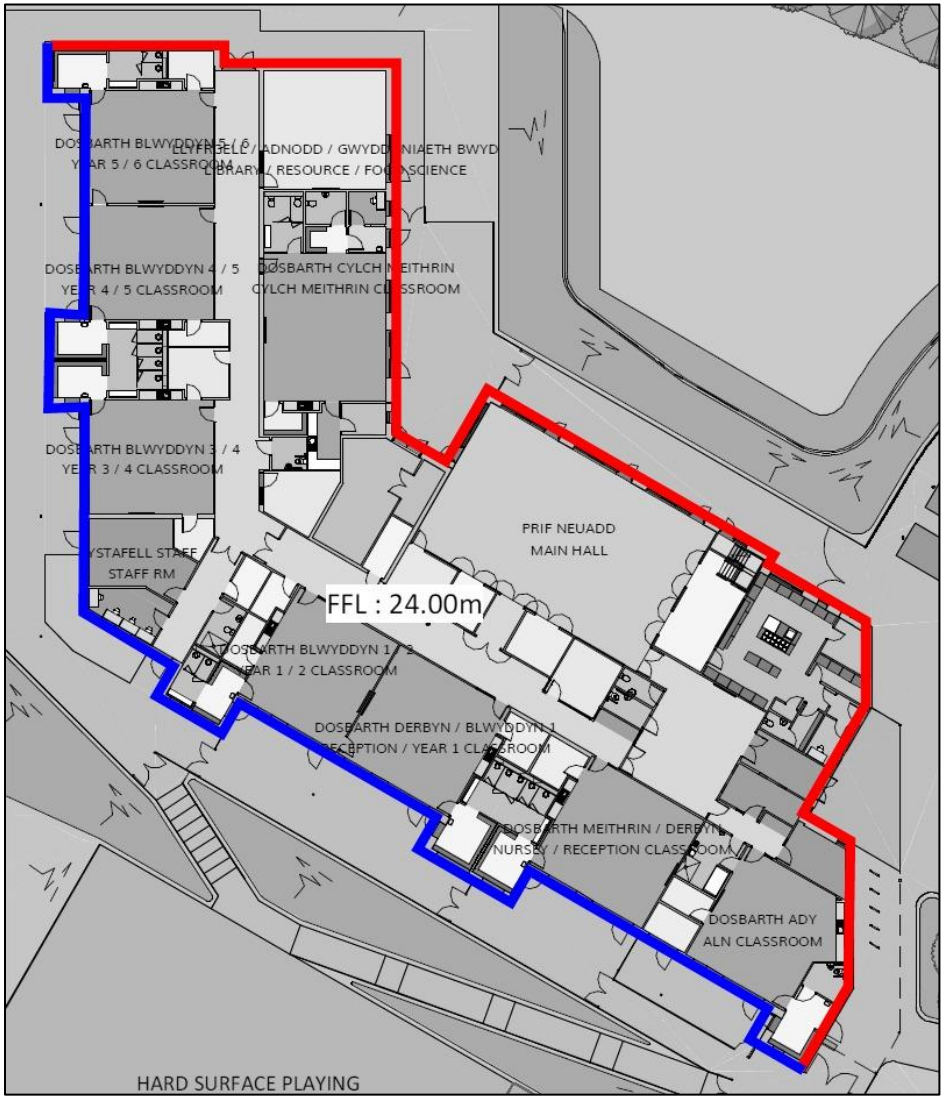


Figure 3 – Marked-up plan showing where the glazing specifications from Table 11 apply

8. Reverberation Time

8.1. Target Criteria

BB93 gives required maximum reverberation times for different teaching areas within schools Levels stipulated are maximum reverberation times; however, it is recommended that reverberation times should be reduced as far as practicable for teaching areas. The target performance criteria for the rooms in the School have been reproduced in Table 12 and have been illustrated on marked up plans in the appendix.

Room type		T_{mf} (seconds)
Teaching and learning	Nursery school room, primary school: Classroom, class base, general teaching area, small group room, SEN calming room	≤ 0.6
	Teaching space intended specifically for students with hearing or communication needs	≤ 0.4 (see note 3)
	Atrium, foyer, entrance hall, circulation space not used for teaching and learning	≤ 1.5
	Assembly hall, multi-purpose hall (drama, PE, audio / visual presentation, assembly, occasional music)	0.8 – 1.2
Ancillary	Office, medical room, staff room	≤ 1.0
	Corridor, Stairwell	(see note 2)
	Coats and locker area, changing area, toilets, kitchens	≤ 1.5

1. *Reverberation times for ancillary areas are for guidance only*
2. *Sound absorption within corridors, entrance halls and stairwells is calculated according to Approved Document E*
3. *T ≤ 0.4 averaged from 125kHz to 4kHz octave bands and T ≤ 0.6 in each individual band in the range*

Table 12 – BB93 performance standards for mid-frequency reverberation time (T_{mf})

Provision of suitable reverberation times enables clear communication of speech between teacher and student, and between students in teaching and study spaces. Reverberation times are generally determined by room volume and surface finishes.

8.2. Design Specifications

Reverberation times are generally determined by room volume and surface finishes. A schedule of surface finishes has not yet been provided by the client. Therefore, a number of assumptions have been made about the materials, these have been detailed in Table 13.

Building element	Description
Walls	Plasterboard on metal frame (new-build)
	Painted, plastered masonry walls (refurbished)
	Class 'A' wall panel[7]
Ceiling	Class 'A'[8]
	Class 'C'[9]
Floor	Carpet – 5mm needlefelt[10]
	Vinyl[11]
Doors	Solid core timber door[12]
Glazing	Double glazing[13]

Table 13 – Surface finishes assumed for the purposes of reverberation time calculations

Table 13 and Table 14 below provide a summary of reverberation time requirements within the School along with recommended absorptive treatments for the new-build extension and the refurbished main building, respectively.

[7] Ecophon Akusto Texona, 50mm overall system depth
[8] Ecophon Focus A ceiling tile, 200mm overall system depth
[9] Armstrong Dune Vector ceiling tile
[10] Danish Buildings Research Institute (derived from other sources - ODEON)
[11] Petersen, J, Rumakustik, 1983 (Odeon)
[12] Bobran, H.W., "Handbuch der Bauphysik" Verlag Ilstein Berlin 1973 (Odeon)
[13] Original figures from Building Bulletin 51 published in 1976

New-build classrooms have been specified with Class 'A' ceilings. In some situations a Class 'C' ceiling may suffice; however, this will depend on the exact absorption spectrum of the chosen product and other room finishes. Experience of commissioning recent school projects has shown that a 0.6s T_{mf} reverberation time can be difficult to achieve where other compromises have been made on site.

It has been assumed that there are no areas specifically designed for use by students with a hearing impairment or other special communication needs.

Room	Floor finish	Required T_{mf}(s)	Ceiling finish	Notes
Ground Floor				
Classrooms	Carpet or Vinyl	≤0.6s	100% Class 'A'	2.7m ceiling height
SEN Classroom	Carpet or Vinyl	≤0.4s (each octave band ≤0.6s)	Ecophon Master A + 2x Extra Base Pads	2.7m ceiling height Base pads located around room perimeter
Small Group Rooms	Carpet or Vinyl	≤0.6s	100% Class 'A'	2.7m ceiling height
Activity Hall	Sports flooring	0.8-1.2s	100% Class 'C'	7m ceiling height 60m² Ecophon Akusto Texona wall panels required[a] Curtains with 50% gather to all glazing
Ancillary spaces	Carpet or Vinyl	Various	100% Class 'C'	2.7m ceiling height

[a] Wall panels should be located as close to head height as possible

Table 14 – Reverberation time requirements and recommended absorptive treatments

8.3. Corridors and Circulation Spaces

BB93 requires additional absorption to corridors, stairwells, and entrance halls, so that unwanted sound is absorbed and does not interfere with teaching areas. Approved Document E, Section 7, provides 2 methods for calculating the amount of absorptive material required to comply.

Method A requires that for entrance halls, corridors and hallways, an area equal to or greater than the floor area must be covered in a Class C absorber (as defined in BS EN ISO 11654:1997) or better.

9. Summary & Conclusions

This report identifies applicable criteria within Building Bulletin 93 'Acoustics design of Schools: Performance Standards' and assesses the current proposals against these requirements.

Marked-up drawings have been provided to assist the design team in identifying required minimum partition performance. Sample constructions have also been suggested to meet these requirements. It is expected that this report will be reviewed and updated during the design process, in accordance with the development of the scheme.

9.1. Potential APSs

In some areas, strictly applying the criteria in BB93 may affect the useability of the building and alternative performance standards have been proposed. The following APSs should be discussed with stakeholders to ensure that the useability of the building isn't compromised.

(1) There are a number of situations where two classrooms separated by a wall containing an interconnecting door. In these instances, the partition guidance for circulation spaces has been applied. The future users of the school should be made aware that he interconnecting door will compromise the sound insulation.

(2) The sound insulation of the doors to the Main Hall have been reduced from 35dB R_w to 30dB R_w because a lobby has been provided.

(3) Cloak rooms that do not have a door to the corridor have been treated as part of the corridor.

Appendix

APPENDIX A: Summary Information

Required ISO Test Report Information (cross referenced where required)			
		Measurements carried out to:	Analysed to:
A	Standards	BS 7445-1: 2003 BS 7445-2: 1991	BB93 BREEAM HEA5
B	Organisation performed the measurements	noise.co.uk Ltd, The Haybarn, Newnham Grounds, Kings Newnham Lane, Bretford, Coventry, CV23 0JU.	
C	Name of Client	Melin Consultants	
D	Full site address	Ysgol Treferthyr Criccieth	
E	Date of surveys	Survey Date: 14th October 2020 – 15th October 2020	
F	Description & identification of Proposed Development	Assessment of the proposed school for compliance with BREEAM and BB93 criteria	
G	Brief Description of details of Procedure & equipment	See Section 5 of this report.	

APPENDIX B: Technical Appendix

Measurements were made using the following equipment:

Monitoring Position	Sound Level Meter (Serial Number)	Calibrator (Serial Number)
Position 1	Norsonic 140 (1405559)	Norsonic 1251 (33823)
Position 2	Norsonic 140 (1405560)	Norsonic 1251 (33825)

The equipment has traceable calibration. The sound level meter was calibrated immediately prior to and immediately after the measurements were carried out.

Sound Level Meter	Before	After
Norsonic 140 (1405559)	114.0 dB	114.0 dB
Norsonic 140 (1405560)	114.0 dB	114.0 dB

There was no adverse deviation.

APPENDIX C: Background Sound Level Data

Date	Time	$L_{Aeq,15\text{-}mins}$	
		Position 1	Position 2
14/10/2020	10:00:00	69.6	59.0
14/10/2020	10:15:00	69.0	58.3
14/10/2020	10:30:00	69.6	60.0
14/10/2020	10:45:00	69.4	59.9
14/10/2020	11:00:00	70.1	60.5
14/10/2020	11:15:00	68.8	59.4
14/10/2020	11:30:00	69.0	60.0
14/10/2020	11:45:00	69.7	59.8
14/10/2020	12:00:00	70.0	60.1
14/10/2020	12:15:00	69.3	59.2
14/10/2020	12:30:00	69.0	58.2
14/10/2020	12:45:00	68.8	59.4
14/10/2020	13:00:00	69.2	59.8
14/10/2020	13:15:00	68.6	60.2
14/10/2020	13:30:00	68.3	59.4
14/10/2020	13:45:00	66.8	58.9
14/10/2020	14:00:00	66.6	58.7
14/10/2020	14:15:00	69.9	59.5
14/10/2020	14:30:00	69.0	58.9
14/10/2020	14:45:00	70.2	59.8
14/10/2020	15:00:00	70.3	59.8
14/10/2020	15:15:00	68.9	58.9
14/10/2020	15:30:00	69.6	60.0
14/10/2020	15:45:00	71.0	60.3
14/10/2020	16:00:00	69.2	58.9
14/10/2020	16:15:00	70.2	59.9
14/10/2020	16:30:00	70.5	60.0
14/10/2020	16:45:00	70.7	62.1
14/10/2020	17:00:00	70.6	59.7
14/10/2020	17:15:00	69.6	59.2
14/10/2020	17:30:00	69.3	57.7
14/10/2020	17:45:00	68.2	56.2
14/10/2020	18:00:00	67.6	57.4
14/10/2020	18:15:00	70.2	57.6
14/10/2020	18:30:00	67.8	56.8
14/10/2020	18:45:00	66.5	56.1
14/10/2020	19:00:00	65.7	55.8
14/10/2020	19:15:00	66.4	55.7
14/10/2020	19:30:00	65.2	53.6
14/10/2020	19:45:00	65.1	61.3
14/10/2020	20:00:00	64.1	53.8
14/10/2020	20:15:00	62.3	52.2
14/10/2020	20:30:00	60.7	53.1
14/10/2020	20:45:00	60.7	51.5
14/10/2020	21:00:00	61.9	51.4
14/10/2020	21:15:00	62.6	51.2
14/10/2020	21:30:00	60.0	49.6
14/10/2020	21:45:00	63.8	52.4
14/10/2020	22:00:00	60.6	51.8
14/10/2020	22:15:00	61.5	51.3
14/10/2020	22:30:00	58.8	48.7
14/10/2020	22:45:00	58.3	48.7
14/10/2020	23:00:00	55.5	45.1
14/10/2020	23:15:00	57.6	47.9
14/10/2020	23:30:00	56.4	45.8
14/10/2020	23:45:00	58.0	48.4
15/10/2020	00:00:00	56.9	46.7
15/10/2020	00:15:00	47.6	42.4
15/10/2020	00:30:00	51.5	42.1
15/10/2020	00:45:00	35.2	36.8
15/10/2020	01:00:00	55.2	44.9
15/10/2020	01:15:00	48.1	39.9
15/10/2020	01:30:00	53.4	44.0
15/10/2020	01:45:00	53.6	44.8
15/10/2020	02:00:00	46.6	43.2
15/10/2020	02:15:00	45.7	39.9
15/10/2020	02:30:00	55.0	48.5
15/10/2020	02:45:00	49.5	45.4
15/10/2020	03:00:00	36.0	40.9
15/10/2020	03:15:00	53.7	45.5
15/10/2020	03:30:00	35.5	38.5
15/10/2020	03:45:00	57.2	47.4
15/10/2020	04:00:00	51.6	40.3

Date	Time	$L_{Aeq,15\text{-}mins}$	
		Position 1	Position 2
15/10/2020	04:15:00	57.3	47.8
15/10/2020	04:30:00	52.3	44.7
15/10/2020	04:45:00	60.6	50.1
15/10/2020	05:00:00	60.5	51.9
15/10/2020	05:15:00	60.9	51.2
15/10/2020	05:30:00	60.2	51.4
15/10/2020	05:45:00	63.0	53.5
15/10/2020	06:00:00	62.0	51.1
15/10/2020	06:15:00	64.4	57.4
15/10/2020	06:30:00	63.6	57.4
15/10/2020	06:45:00	66.1	57.5
15/10/2020	07:00:00	65.7	57.6
15/10/2020	07:15:00	67.0	58.9
15/10/2020	07:30:00	68.2	59.6
15/10/2020	07:45:00	68.3	59.2
15/10/2020	08:00:00	69.5	60.9
15/10/2020	08:15:00	68.9	59.7
15/10/2020	08:30:00	70.2	59.9
15/10/2020	08:45:00	68.8	60.2
15/10/2020	09:00:00	70.1	60.0
15/10/2020	09:15:00	69.0	60.5

APPENDIX D: Service Details

The following details assume that the size of penetration is only slightly larger than the service passing through the partition. In the case where larger holes have been made to allow services to pass, they will require additional treatments.

Partition type:	R_w 35,40,45dB	$D_{nT,w}$ 30dB	$D_{nT,w}$ 35dB	$D_{nT,w}$ 40dB	$D_{nT,w}$ 45dB	$D_{nT,w}$ 50dB	$D_{nT,w}$ 55dB
Mechanical services							
Single un-insulated metal pipe 15-100mm	*See table below*	A	A	A	A	A	A
Single insulated metal pipe 35-65mm		A	A	A	A	A	A
Single un-insulated plastic pipe 32-108mm		A	A	A	A	A	A
Ventilation duct serving adjacent rooms – circular		B	B	B	B	C	C
Ventilation duct serving adjacent room – rectangular		B	B	B	B	C	C
Ventilation duct passing through room – circular		F	F	F	F	F	F
Ventilation duct passing through room – rectangular		F	F	F	F	F	F
Tray with refrigerant lines and cables		D	D	D	D	E	E
Electrical services							
Conduit	*See table below*	A	A	A	A	A	A
Single cable (fire alarm)		A	A	A	A	A	A
Tray with cables 50-300mm		D	D	D	D	E	E
Trunking with lid and cables 50-100mm		D	D	D	D	E	E
Data basket with cables 50-300mm		D	D	D	D	E	E
Dado trunking		D	D	D	D	E	E

Detail #A

Penetration should be packed with mineral wool and well sealed with non-hardening mastic

Detail #B

Penetration should be packed with mineral wool and well sealed with non-hardening mastic

Crosstalk attenuator should be fitted where a common ventilation duct serves vents in multiple rooms

Detail #C

Penetration should be packed with mineral wool and well sealed with non-hardening mastic

Crosstalk attenuator should be fitted across partition

Detail #D

Penetration should be packed with mineral wool and well sealed with non-hardening mastic

Tray/trunking/basket can pass through partition

Detail #E

Tray/trunking/basket should be cut either side of partition with no hard contact through penetration

Services should be passed via a sleeve through penetration

Sleeve/partition junction should be well sealed with non hardening mastic

Any internal void within the sleeve should be filled with mineral wool

Detail #F

Penetration should be packed with mineral wool and well sealed with non-hardening mastic

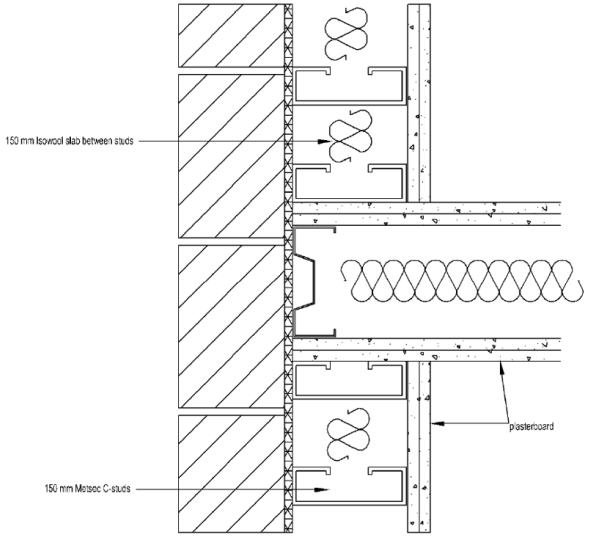
Duct should be lagged with 15mm Muftilag P

Where pipework services are to be passed through partitions in sleeves, it is recommended that sleeves should be chosen so that pipework fits snugly once installed. Larger diameter sleeves will need to be densely packed with mineral wool once the pipe has been passed through.

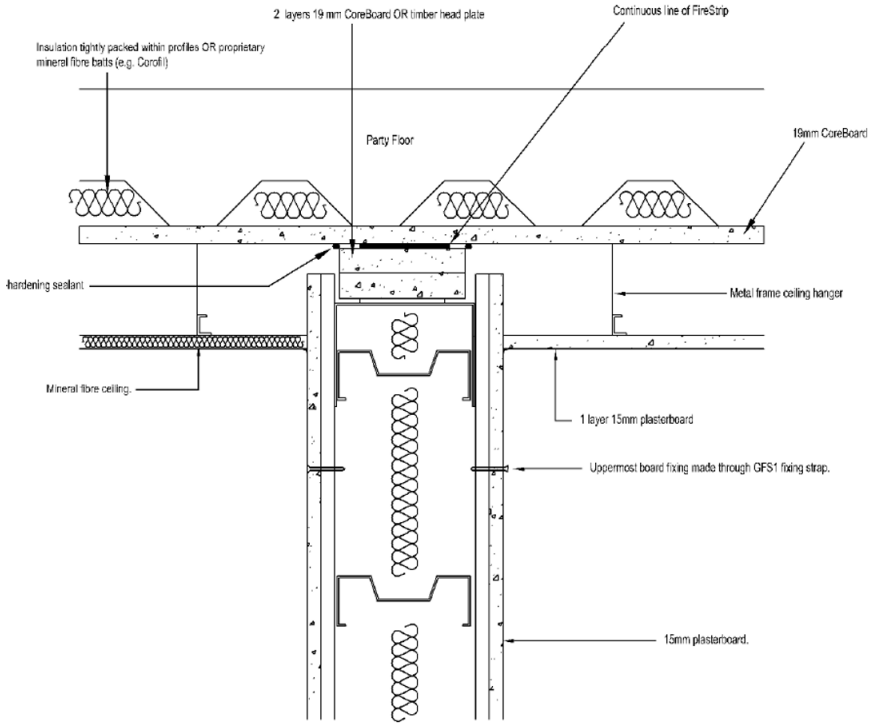
Should a penetration be significantly larger than the services passing through the partition (for example, where whole blocks have been removed), additional treatments will be necessary.

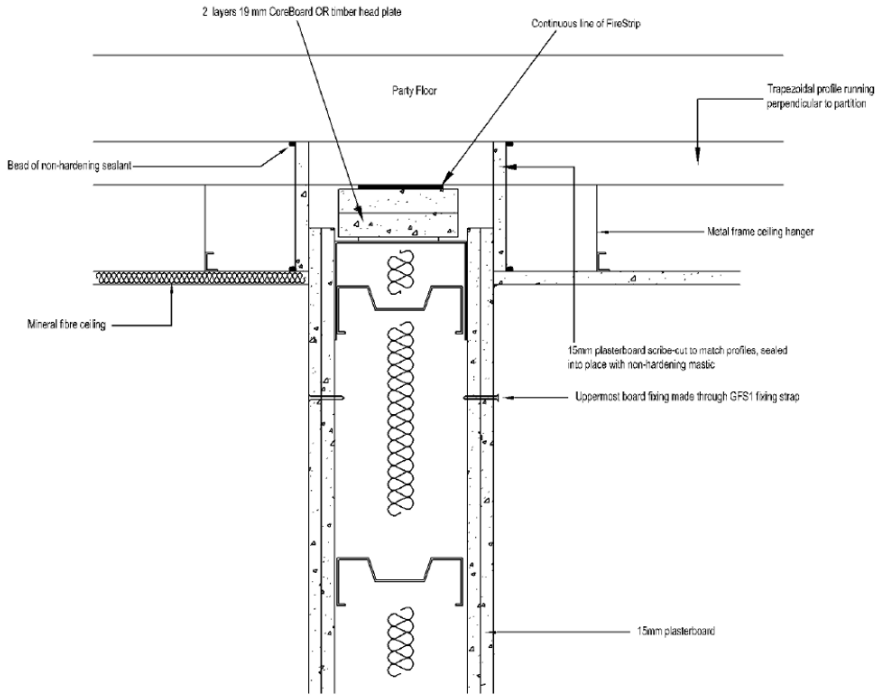
R_w 40 & R_w 45 dB partitions are not required to have their performance tested on site; however it is considered that service penetrations through such partitions should be sealed as followed in order to maintain acoustic integrity:

Room 1	Room 2	Treatment
Classroom	Classroom	2x 50mm mineral fibre batt, sealed with non-hardening mastic
Classroom	WC	
Classroom	Corridor	1x 50mm mineral fibre batt, sealed with non-hardening mastic
Office	Corridor	
Office	WC	
WC	WC/Changing room	
WC	Corridor	No acoustic requirement



NOTE: This is a typical detail. Although exact build-ups may vary, the principles should remain constant. If in doubt please consult the project engineer before construction.



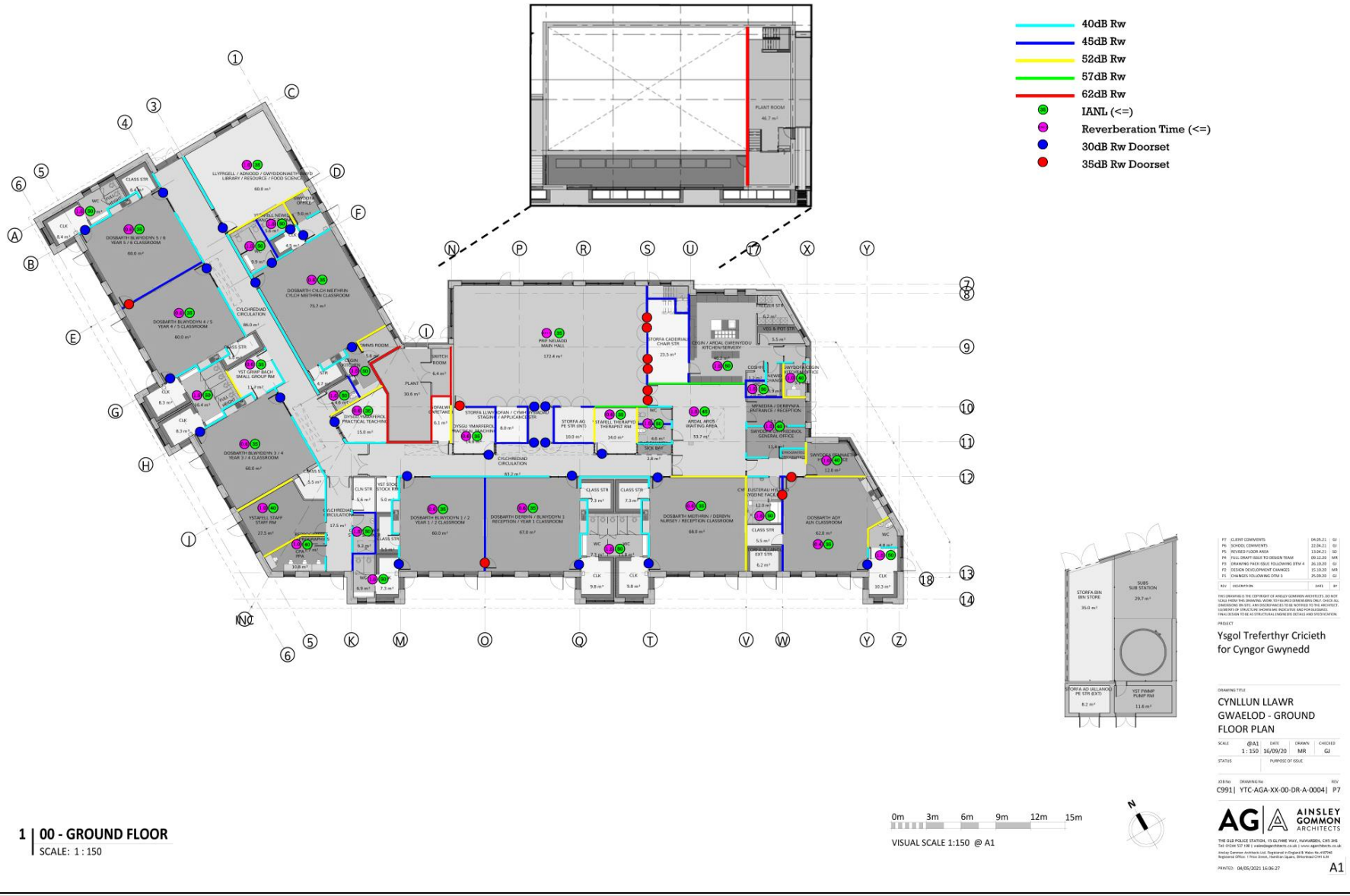


NOTE: This is a typical detail. Although exact build-ups may vary, the principles should remain constant. If in doubt please consult the project engineer before construction.

APPENDIX D: Client Drawings


ALLWEDD ADRAN / DEPARTMENT KEY
Learning Resources - Adnoddau Dysgu
Hall - Neuadd
Basic Teaching - Dysgu Sylfaenol
Teaching Storage - Storfa Dysgu
Other Storage - Storfa Arall
Non-Net Area - Ardal Di-Net
Staff & Admin. - Staff & Gweinyddiaeth
1 | 00 - GROUND FLOOR
SCALE: 1 : 150
0m 3m 6m 9m 12m 15m
VISUAL SCALE 1:150 @ A1
Ysgol Treferthyr Cricieth
for Cyngor Gwynedd
CYNLLUN LLAWR
GWAELOD - GROUND
FLOOR PLAN
@A1
1 : 150
16/09/20
MR
GJ
C991| YTC AGA XX 00 DR A 0004| P7
AINSLEY
GOMMON
ARCHITECTS
A1

APPENDIX D: Marked-Up Drawings



1 | 00 - GROUND FLOOR
SCALE: 1 : 150