BB93 noise Assessment for extension to William Stukeley school in Holbeach

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REPORT No.:	SS/J3696/18358-1
DATE:	March 2023

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SUMMARY

A noise assessment has been carried out for the proposed extension of the William Stukeley school in Holbeach. Using measurement and prediction this report considers all of the relevant criteria, as required by Building Bulletin 93 (BB93 – Reference 1), to aid the design team in providing optimum acoustics for the students and teachers who will work within the rooms of the building.

This design study looked at the acoustics of the classrooms as well as in the corridors, entrance halls and stairwells, the results are summarised below:

1) The ambient noise levels within all rooms will comply with the regulations criteria provided this report's recommendations are followed. The report details maximum open areas for ventilation.

2) The report documents acoustic specifications of walls separating teaching areas which will comply with the regulations and includes a sample proprietary product. Further assessment is required at detailed design stage.

3) The walls of the new corridors which are formed from existing exterior walls will comply with the regulations. The report documents acoustic specifications for other corridor walls and includes a sample proprietary product.

4) If absorbent ceilings of the specification detailed in this report are installed in the teaching spaces the regulations on reverberation time in teaching spaces will be complied with.

5) If absorbent ceilings of the specification detailed in this report are installed in the corridors the regulations on reverberation time in corridors will be complied with.

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1 OBJECTIVES

1.1 To assess the acoustic performance of the extension to William Stukeley school in Holbeach against requirement E4 of the Approved Document E (Reference 2) and the Building Bulletin 93 (Reference 1).

1.2 To recommend solutions to any problems identified by the assessment.

2 PERFORMANCE STANDARDS

The Approved Document E states in condition E4:

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 noise appropriate to its intended use.

Document E states further:

In the Secretary of State's view, the normal way of satisfying Requirement E4 will be to meet the values for sound insulation, reverberation time and internal ambient noise which are given in Section 1 of Building Bulletin 93. Acoustic Design of Schools. A Design Guide, DfES 2003. ISBN: 0 11271 105 7

BB93 specifies the acoustic performance standards for schools; these recognise research which has shown that acoustics play a vital role in the learning environment. BB93 defines seven Performance Standards which aim to achieve clear communication of speech and optimal acoustics for study activities, they are:

2.1 Indoor ambient noise levels in unoccupied spaces.

2.2 Airborne sound insulation* between spaces.

2.3 Airborne sound insulation between circulation spaces and other spaces used by students.

2.4 Impact sound insulation of floors (not applicable for this project)

2.5 Reverberation in teaching spaces.

2.6 Sound absorption in corridors, entrance halls and stairwells.

2.7 Speech intelligibility in open plan spaces (not applicable for this project).

The relevant parts of the standard are discussed in greater detail in section 4.

***See Appendix 1 for Glossary of Terms**

3 DETAILS OF EXTENSION

The extension will comprise of the following:

- Three new classrooms will be added to at the south of the site.
- The existing Hall will be extended to the east.
- The staff room on north-east of the site will be extended on the north and some toilets and a store room will be added.

Figure 1 shows layout drawings of the current and complete site. Figure 2 shows the acoustic criteria for the school that must be achieved in the teaching spaces.

4 RESULTS OF THE ASSESSMENT

4.1 Indoor ambient noise levels in unoccupied spaces

4.1.1 Introduction

The aim of this standard is to provide a suitable noise level for clear speech communication and for study activities. The ambient noise includes sources such as traffic or industrial noise, but excludes noise from school equipment or teaching activities (this last item is covered by other performance standards within BB93).

4.1.2 External noise

The indoor ambient noise predictions are based on external noise measurements carried out on site by Acoustic Associates (Peterborough). The monitoring is documented in Appendix 2.

4.1.3 Assessment

Two rooms were chosen to represent the affected rooms. The ambient noise inside the selected rooms was predicted based on the measured external noise and assumptions based on the plans, sections and elevation in the architect's drawings. The results are shown in Table 1.

Note: The guidance in BB93 states that for classrooms that are naturally ventilated the windows should be assumed to be open.

Room	BB93 Performance Standard $L_{Aeq,30minutes}$ dB(A) (maximum)	Assumed external noise level $L_{Aeq,30minutes}$ dB(A)	Assumed construction	Predicted internal noise level $L_{Aeq,30minutes}$ dB(A)	Maximum permissible windows open area while meeting column 2 performance standard m^2
Extended Hall	35	43	19.7 m^2 of standard double-glazing on eastern facade	<20	2.2
New classrooms	35	49	32 m^2 of standard double-glazing on eastern and southern facades	<20	3

Table 1 – Indoor ambient noise levels

Table 2 details the maximum permissible noise levels in the new teaching spaces. The levels shown are inclusive of the ambient noise levels detailed in Table 1.

Room	BB93 Performance Standard $L_{Aeq,30minutes}$ dB(A) (maximum)	Predicted $L_{Aeq,30minutes}$ dB(A) from external noise	Acceptable maximum sound power level (L_{wA} dB(A)) of ventilation/AC equipment located in room
Extended Hall	35	<20	49
New classrooms	35	<20	45

Table 2 – Indoor ambient noise levels

4.1.4 Conclusions and Recommendations

The noise levels in rooms as shown in Table 1 show that noise levels comply with the requirements of BB93 with windows closed or open for ventilation assuming standard double glazing is installed of specification R_W.31 dB or better. Given that the open areas permissible for the rooms without causing excessive noise internally are large (2.2 m^2 for the Hall and 3 m^2 for the classroom), a natural ventilation strategy is an option for the design team.

Table 2 details maximum noise levels permissible for ventilation plant in column 4. The number given is the cumulative level of all items of plant operating.

It should be noted that in the Hall noise levels are currently excessive with the fans turned on and exceed the criterion of L_{Aeq} 35 dB(A) by 12 dB (see Appendix A2.2.2).

4.2 Airborne sound insulation between spaces

4.2.1 Introduction

This part of the BB93 standard states that teaching spaces are required to be acoustically insulated from other teaching spaces. The amount of insulation depends on the activities that the spaces are used for. Different types of rooms are assigned 'Activity' and 'Tolerance' levels and using these guidelines the standardised level difference $D_{nT(Tmf,max)w}$ required between the spaces can be determined.

4.2.2 Assessment

This prediction assumes that the quality of the build is carried out to a high standard, however flanking transmission is possible. In order to account for possible flanking transmission in the final build 5 dB was subtracted from the predicted $D_{nT(Tmf,max)w}$, in accordance with BB93 requirements.

Table 3 shows the predicted airborne sound insulation values for representative partitions.

Type	Source Room	Activity	Receiver Room	Tolerance	BB93 Performance Standard $D_{nT(Tmf,max)w}$ dB	Predicted $D_{nT(Tmf,max)w}$ dB*	Construction
Wall	Extended Assembly Hall	High	Classroom	Low	≥55	>60	Partition formed from existing external wall
Wall	Classroom 03 or 02	Medium	Classroom 03 or 04	Low	≥45	>50	British Gypsum A206A198 or similar specification.

*This must include a 5 dB subtraction to account for flanking transmission in the final build.

Table 3 – The $D_{nT(Tmf,max)w}$ values for sound insulation between the teaching spaces.

4.2.3 Conclusions and Recommendations

If the partitions are either formed from the existing external wall or built from British Gypsum spec A206A198 (or equivalent) they are likely to comply with the requirements of BB93. However, the following should be noted:

- Manufacturers advice should be followed installing the partitions. In particular gaps between the inner leaves should not be breached other than by the studs.
- The partitions should be complete, built to the roof and gaps filled with a flexible closer e.g., mineral wool.

- The detailed design stage must assess the overall noise transmission into the teaching space, including the effect of “flanking” noise. Acoustic Associates (Peterborough) can advise further when the construction details are available.

4.3 Airborne sound insulation between circulation spaces and other spaces used by students.

4.3.1 Introduction

This part of the standard looks at minimising the sound transmitted from spaces such as corridors and stairwells into sensitive spaces such as classrooms. BB93 requires the walls between these spaces to have a certain weighted Sound Reduction Index, R_w.

4.3.2 Assessment

Table 4 shows estimated sound insulation values (R_w dB) values of walls and doors between corridors and other rooms used by students.

Wall separating teaching space from corridor	Sample construction	BB93 Performance Standard R_w – dB	Estimated R_w – dB
Walls formed from existing external wall	Block/cavity/Brick from existing external walls	≥40	>50
	MDF Solid Core doorsets (assumed 44mm thick)	≥30	>30
Walls formed from new lightweight partitions	British Gypsum A206A164	≥40	41
	MDF Solid Core doorsets (assumed 44mm thick)	≥30	>30

Table 4 – R_w values between circulation spaces and the teaching spaces.

4.3.3 Conclusions and Recommendations

- The corridor walls formed from the existing external wall will comply with the performance requirements of BB93.
- The new corridor walls will comply with the performance requirements of BB93 if they have a sound insulation of R_W 40 dB or greater, e.g. British Gypsum spec A206A164, and are installed following manufacturers instructions.
- The doors from the teaching areas will comply with the performance requirements of BB93 if they have a sound insulation of R_W 30 dB or greater. This can be achieved by a 44mm thick MDF solid core doorset. Compression or wipe seals should be used around the door's perimeter along with a threshold seal beneath. Either a drop-down or wipe type threshold seal is suitable.

4.4 Impact sound insulation of floors.

There are no separating floors in this single storey development.

4.5 Reverberation in teaching spaces

4.5.1 Introduction

BB93 documents recommended reverberation times for all types of teaching spaces. The times vary depending on how the room is used. The main aim is to provide suitable reverberation times for clear communication of speech and for music and performance.

The reverberation times are quoted as mid-frequency reverberation times, T_{mf}, which is the average of the of the reverberation times in the 500Hz, 1kHz and 2kHz octave bands.

4.5.2 Assessment

Two following two rooms were selected for the assessment of reverberation times:

- The main hall which will be extended
- Classroom 01A (representing all 4 new classrooms)

Table 5 shows the predicted mid-frequency reverberation times for the selected rooms along with recommendations for upgrade in column 3.

Room	BB93 Performance Standard Required Mid-Frequency Reverberation times (seconds)	Predicted Mid-Frequency Reverberation Times (seconds)
Assembly Hall	*0.8-1.2	1.1 With class 'D' absorber on ceilings
Classroom – 02-04	0.6	0.6 With class 'D' absorber on ceilings

* The current reverberation time of the Assembly Hall is 1.1 seconds (see Appendix A2.2)

Table 5 – Reverberation time values.

4.5.3 Conclusions and Recommendations

The classrooms and Assembly Hall should have absorptive ceilings of at least Class "D" in order to comply with the Regulations.

The Assembly Hall current reverberation time of 1.1 seconds is ideal for music and theatre and adding class "D" ceiling in the extended section will maintain this . More absorption should be added if the room is intended for speech. Acoustic Associates (Peterborough) can advise if required.

4.6 Sound absorption in corridors, entrance spaces and stairwells

The objective of this standard is to ascertain that sound is absorbed in corridors, entrance spaces and stairwells so that it does not disturb study activities in adjacent rooms. BB93 requires that the amount of absorption be calculated according to Document E section 7. This suggests 2 methods (Methods A and B). Method A is suitable for stairwells and Method B is more suitable for entrance halls, hallways, and corridors.

4.6.1 Conclusions and Recommendations

In order to comply with the requirements of BB93 the ceilings of the halls should be treated with a class “D” absorber. See Figure 3 for different absorption class materials.

4.7 Other issues

4.7.1 Practical Area

The drawings show a “Practical Area” in the corridor adjacent to the three new classrooms. The following guidance from Building Bulletin 93 is relevant (section 4.10.1).

> *“Central resource areas are often located adjoining the circulation spaces of design and technology departments. A common arrangement uses the central resource area predominantly for individual and small group work but such areas are not generally suitable for whole class teaching. Usually, there are areas of glazing and doors between the central resource area and adjacent practical spaces. The central area should be suitable for most design/resource activities as long as the circulation is restricted to the department and does not include access to other parts of the school”*

The design shows the space at the end of a corridor, It should be noted by the client that this area is not suitable for teaching other than small groups.

4.7.2 Rain Noise

The extension contains no rooflights so rain noise is unlikely to be an issue.

REFERENCES

1. *Building Bulletin 93 - Acoustic of schools: A design guide;* Institute of Acoustics and Association of Noise Consultants, 2015.
2. HM Government. *Approved Document E: Resistance to the passage of sound. The Building Regulations 2010 (2003 edition incorporating 2004, 2010, 2013 & 2015 amendments), ISBN 978 1 85 946 616 2;*, 2010.
3. British Gypsum. *White Book, https://www.british-gypsum.com/specification/white-book-specification-selector;*, 2023 .
4. *Document F Ventilation Regulations;* thenbs, 2010.
5. *Insul noise prediction software v 9.0;* Marshall Day.
6. Bastian Acoustic Predicitve Software V2.3.98 - Datakustik.
7. *BS EN ISO 11654:1997 Acoustics – Sound absorbers for use in buildings*.

Appendix 1 – Glossary of Terms

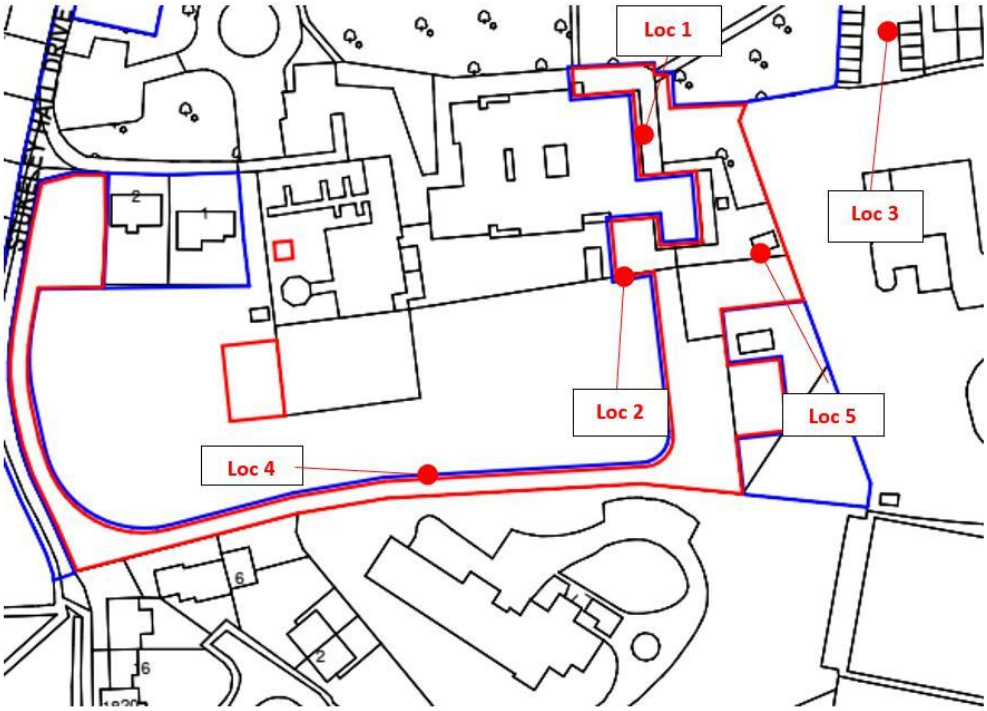
Absorption coefficient	A quantity characterising the effectiveness of a sound absorbing surface. The proportion of sound energy absorbed is given as a number between zero (for a fully reflective surface) and one (for a fully absorptive surface).
Absorption classes	This is a classification of a material's ability to absorb sound as defined in a standard EN ISO 11654. Materials are classed A-E with class A being the most absorbent,
Absorptive material	Material that absorbs sound
Airborne sound	Sound propagating through the air
Airborne Sound Insulation	Sound insulation that reduces transmission of airborne sound between buildings or parts of buildings.
ANC	The Association of Noise Consultants, who are an accreditation body specifically for organisations who carryout Pre completion sound insulation testing.
ANC accredited tester	Minimum qualification status for an individual who carries out pre completion sound insulation testing.
Caulking	Process of sealing joints.
Cavity Stop	A proprietary product or material such as mineral wool used to close the gap in a cavity
C_{tr}	The correction to a sound insulation quantity (such as $D_{nT,W}$) to take account of a specific sound spectrum. See BS EN ISO 717-1:1997
Decibel (dB)	The unit used for many acoustic quantities to indicate the level with respect to a reference level.
D_{nT}	The difference in sound level between a pair of rooms, in a stated frequency band, corrected for the reverberation time. See BS EN ISO 140-4:1998.
Flanking transmission	Sound transmitted between rooms via flanking elements instead of directly through separating elements or along any path other than the direct path.
Floating floor	A floating floor consists of a floating layer and resilient layer.
IOA	The Institute of Acoustics.

Impact sound	Sound resulting from direct impact on a building element.
Impact sound insulation	Sound insulation which reduces impact transmission from direct impacts such as footsteps on a building element. Impact tests are usually conducted on a separating floor.
Independent ceiling	A ceiling which is fixed independently of a separating floor or an internal floor.
Internal floor	Any floor that is not a separating floor
Intermediate landing	A landing between two floors
Internal wall	Any wall that does not have a separating function.
Mass per unit area	Is expressed in terms of kilograms per square metre (kg/m^2).
Noise	Unwanted sound.
Reverberation	The persistence of sound in a space (room) after a sound source has stopped.
Reverberation Time	The time, in seconds, taken for the sound to decay by 60dB after a sound source has been stopped.
Mid-Frequency Reverberation Time	The average reverberation time across the 500Hz, 1kHz and 2 kHz octave frequency bands.
R_w	The weighted Sound Reduction Index, which is measured in the laboratory.
Speech Transmission Index (STI)	The performance standard for speech intelligibility in open plan teaching spaces. Required values between 0.6 and 1.00.
RASTI	Rapid Speech Transmission Index just considers the 500Hz and 2kHz octave bands.

Appendix 2 – Noise survey

A2.1 Environmental Noise Survey

The site was visited on the 3rd January 2023 and 27th January 2023. Noise measurements were taken at several locations around the site to estimate the ambient noise levels at the location of the new extension. All measurements were taken at 1.5 metres height. Monitoring locations are shown below in Drawing A2.1, the equipment used is shown in Table A2.1 and the results are summarised in Table A2.2.



Drawing A2.1 – Monitoring Locations

Type	Manufacturer	Description	Serial Number	Last Calibration Date	Calibration Certificate No.
Svan 957	Svantek	Sound level meter	27591	12/09/2022	1132547
Svan 957	Svantek	Sound level meter	27517	16/03/2022	1125184
GA 607	Castle	Sound level calibrator	039873	16/03/2022	1125186
Svan 971	Svantek	Sound level meter	28229	15/03/2021	1110164
Svan 971	Svantek	Sound level meter	34935	23/06/2022	1129258

Table A2.1 – Noise instrumentation for environmental measurements

End Time	Comments	Noise level dB(A)		
		$L_{Aeq\ ,15minutes}$	$L_{A90\ ,15minutes}$	$L_{A90\ ,15minutes}$
Monitoring on 3rd January 2023 – Weather was overcast with light showers. Light south-westerly breeze, 2˚C				
Location 1				
09:24	Free-field.North-east corner extension. Distant road traffic and birdsong dominant.	49.1	55.5	43.9
09:39		48.5	53.5	44.8
09:54		48.7	53.4	44.7
10:09		48.8	53.6	45.3
10:24		48.3	52.4	45
10:39		49.5	54.9	45.9
10:54		48.6	53.9	44.8
11:09		48.8	53.6	45.1
11:24		52.5	64	46
11:39		48.8	54.5	45.1
11:54		48.7	53.8	44.6
12:09		49.5	53.9	46.5
Location 3				
09:54	Back lane ,1m from entrance to garages ,1m from wall). Road traffic on Spalding Road dominant. Occasional birdsong and ducks quaking, some noise from nearby gas building which will contribute to background level. 09:46 one car went past slowly on back lane. Another car on back lane at 09:48	57.5	66.3	48
Location 4				
10:14	Free-field . Near to nearest residents to the south. Distant road traffic dominant and birdsong audible. Dustbin collection took place loudly near the houses between approximately 10:18 - 10:25	44.2	50	42
10:29		50.6	60.8	42.8
Location 4				
10:45	Free-field. Distant road traffic and birdsong audible. School bell went off loudly at 10:44	49	49.2	41.5
11:00		44.1	48.8	41.9
Location 5				
11:16	3.5m from wall separating the school site from the nearest residential property to the east. Distant road traffic and occasional birdsong and occasional ducks quacking was audible	44.4	48.8	42.1
Monitoring on 27th January 2023				
Location 2.				

End Time	Comments	Noise level dB(A)		
		$L_{Aeq\ ,15minutes}$	$L_{A90\ ,15minutes}$	$L_{A90\ ,15minutes}$
15:49	Free-field . At the location of the southern boundary of the new teaching extension Dominant noise from distant traffic. Birdsong significant for brief periods.	42.4	47.6	40.1
16:04		44.3	54.8	40.3
16:19		42.9	48.4	41.1

Table A2.2 – Noise measurements

A2.2 Noise measurements within the existing hall

A2.2.1 Survey

The site was visited on the 27th January 2023 and the following noise measurements were taken within the Hall at six locations, with each measurement being of 6 seconds duration.

- Ambient noise measurements with the a/c fans on
- Ambient noise measurements with the a/c fans off
- Reverberation Time measurements

The equipment used is shown in Table A2.3.

Type	Manufacturer	**Description**	**Serial Number**	**Last Calibration Date**	**Calibration Certificate No.**
NOR-118	Norsonic	Sound level analyser	31770	21/03/2022	1125182
NOR-1206	Svantek	Pre-Amplifier	30856	16/03/2022	1125184
ACO-7146	Castle	Microphone	16932	16/03/2022	1125186
310-A	R.C.F	power amplifier loudspeakers	IKX00758	N/A	N/A

Table A2.3 – Noise instrumentation for measurements within the Hall.

2.2.2 Results

The average ambient noise in the Hall was **L_{Aeq} 34.9 dB(A)** with the fans off and **L_{Aeq} 47 dB(A)** with the fans on.

The reverberation time in the hall was measured as **T_{mf} 1.1 seconds.**

Figure 1 – Plan Layout of school

Current layout



Layout following extension



Figure 2 – BB93 Acoustic Criteria

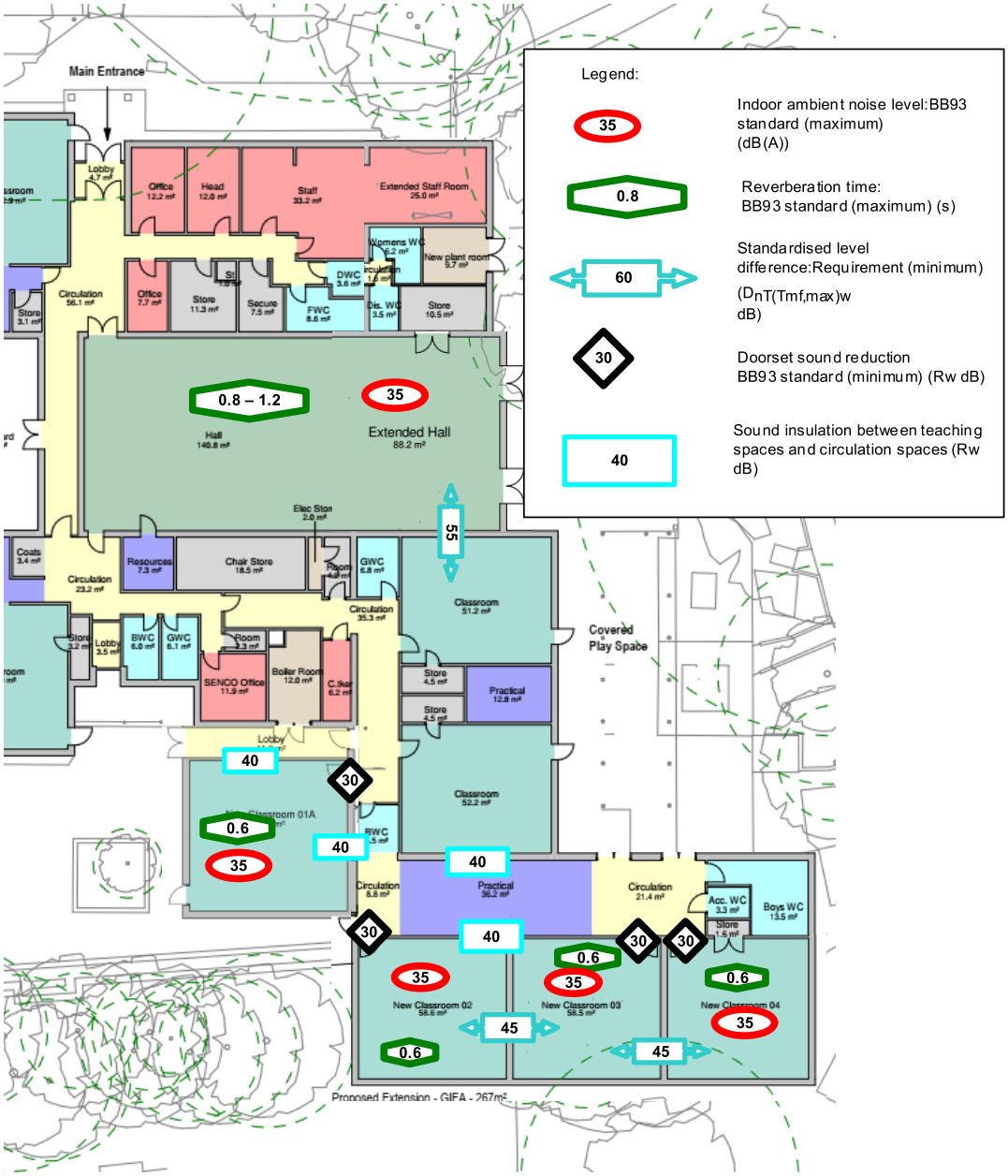
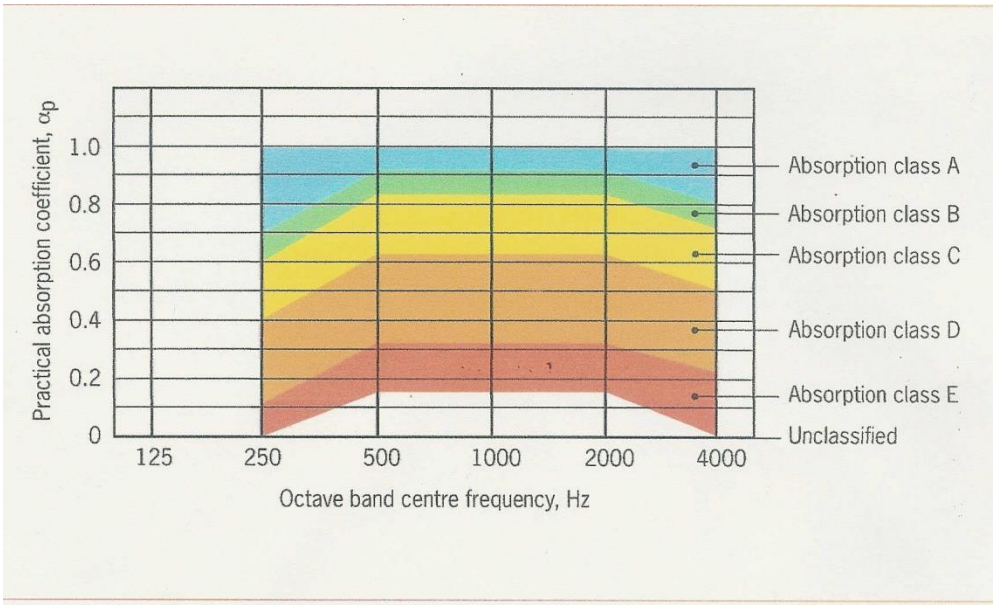


Figure 3 – Different absorption classes and absorptive materials



Sample products for each absorption class from British Gypsum (Reference 3) can be found here Ceilings | British Gypsum (british-gypsum.com) .