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Planning & Building Unit

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Acoustic Performance in Schools

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1. ACOUSTIC PERFORMANCE IN SCHOOLS

1.1 Performance standards

The overall objective of the performance standards in this document is to provide acoustic conditions in schools that (a) facilitate clear communication of speech between teacher and student, and between students, and (b) do not interfere with study activities.

Performance standards on the following topics are specified in this document to achieve this objective:

(i) Rain noise
(ii) Indoor ambient noise levels
(iii) Airborne sound insulation between spaces
(iv) Airborne sound insulation between circulation spaces and other spaces used by students
(v) Impact sound insulation of floors
(vi) Reverberation in various spaces
(vii) Sound absorption in corridors, entrance halls and stairwells

1.2 Rain noise

It is essential that rain noise is considered in the design of light weight roofs and roof lights as it can significantly increase the ambient noise levels. As part of the design process the Design Team should demonstrate to the Client and end user that the roof and roof lights have been designed to minimise rain noise.

BRE document *Rainfall noise from glazed and lightweight roofing* (IP 2/06) propose that the indoor ambient noise levels should not exceed the levels recommended in BB93 (Table 1.0 below) by more than 20 decibels due to heavy rain.

Due to the fluctuating nature of rainfall; laboratory test data on the roof element is required. The standard ISO 140-18 details the test method for determining rainfall noise on building elements including a definition for heavy rain in terms of rainfall rate, drop diameter and fall velocity.

The laboratory data can then be used to estimate the indoor noise levels during heavy rainfall within a given space. This is one proposed method for meeting the requirement stated in this document.

1.3 Indoor ambient noise levels in unoccupied spaces

The objective is to provide suitable indoor ambient noise levels (a) for clear communication of speech between teacher and student, and between students, and (b) for study activities. The indoor ambient noise level in an un-occupied space includes noise contributions from external sources and building services. *Mechanical services can contribute to overall noise levels, and this aspect should receive particular attention at design stage through system design and equipment selection etc., acoustic attenuation should not be necessary in most cases through appropriate design.*

(i) External sources outside the school premises including, but not limited to, noise from road, rail and air traffic, industrial and commercial premises. Due regard to indoor ambient noise level shall be considered in selecting sites for schools and in the design of the school building layout and orientation. Under EU Directive 2002/49/EC transposed by SI number 140 of 2006, Environmental Noise Regulations 2006, it is the responsibility of Local Authorities to produce Noise Maps and Action Plans.

Maps and Action Plans will only be available for agglomerations with:

(a) more than 250 000 inhabitants;
(b) places near major roads which have more than six million vehicle passages a year;
(c) major railways which have more than 60 000 train passages per year and
(d) major airports.

These maps and plans when available on the Local Authority Web sites should be consulted and considered.

(ii) Building services (e.g. ventilation system, plant, etc). Where rooms are naturally ventilated, the ventilators or windows should be assumed to be open as required to provide adequate ventilation. If a room is mechanically ventilated, the plant should be assumed to be running at its maximum duty.

The indoor ambient noise level excludes noise contributions from:

(iii) Teaching activities within the school premises includes noise from staff, students and equipment within the building or in the playground. Noise from adjacent spaces is addressed by the airborne and impact sound insulation requirements.

(iv) Equipment used in the space (e.g. machine tools, CNC machines, dust and fume extract equipment, compressors, computers, overhead projectors, etc). However these noise sources should be considered in the design.

The criteria for indoor ambient noise levels for the various room types are detailed in table 1.0 below.

Table 1.0: Recommended Criteria for Indoor Ambient Noise Levels

Type of room	**Upper limit for the indoor ambient noise level, $L'_{Aeq,30min}$ (dB)**
Primary School: classroom, general teaching areas, small group rooms	**35**
Post-Primary School: classrooms, general teaching areas, seminar rooms, tutorial rooms, language laboratories.	**35**
Music	**35**
Lecture Rooms (less than 50 people)	**35**
Lecture Rooms (greater than 50 people)	**30**
Study Room (individual study, withdrawal, remedial work, teacher preparation)	**35**
Libraries: Quiet study areas Resource areas	**35** **40**
Science Laboratories	**40**
Design and Technology: Resistant materials, CADCAM areas, electronics/ control, textiles, food, graphics, design/ resources areas	**40**
Art Rooms	**40**
General Purpose rooms[1], Assembly halls[1], multi-purpose halls[1] (drama, dining, PE, audio/visual presentations, assembly, occasional music)	**35**
Atria, circulation spaces used by students	**45**
Indoor Sports Hall	**40**
Interviewing/ counselling rooms, medical rooms	**35**
Dining Room[2]	**45**
Kitchens	**50**
Offices/ Staffroom	**40**
Toilets	**50**
Circulation Spaces	**45**

Notes on Table 1.0

1. Halls are often multi-functional spaces (especially for primary schools) used for activities such as dining, PE, drama, music, assembly and performing plays and concerts. In such multi-functional spaces the designer should design to the lowest indoor ambient noise level for which the space is likely to be used. For large halls used for formal drama and music performance lower noise levels than those in Table 1.0 are preferable and levels of 25 dB $L'_{Aeq,30min}$ may be appropriate. In these cases specialist advice should be sought.
2. Dedicated dining rooms only, dining functions of a General Purpose room, as described in post primary school design guidelines TGD 023, should comply with the indoor ambient noise levels for a General Purpose room.
3. For explanation of the measurement units, $L'_{Aeq,30min}$ (dB), refer to BB93 Appendix 1: Basic Concepts and Units.

1.4 Airborne sound insulation between spaces

The objective is to attenuate (i.e. diminish or lesson) airborne sound transmitted between spaces through walls and floors. Table 1.1 contains the required minimum airborne sound insulation values between rooms. These values are defined by the activity noise in the source room and the noise tolerance in the receiving room. In each case the receiving room/space with the most stringent Airborne Sound Insulation value sets the figure for the dividing construction between those spaces.

To achieve the required performance a suitable partition construction should be chosen. The design of joints between partitions is critical in minimising flanking effects. Care should be taken with any suspended ceilings that partitions continue up to floor or roof structure above. Penetrations of partitions should be properly sealed. The elimination of the transmission of noise between spaces is a matter primarily for the Architect and Structural Engineer, however it is the responsibility of the Building Services Consultant Engineer to ensure that building services installation does not infringe on required standards. The design and installation of the Building Services Systems shall ensure that their operation will not interfere with the schools teaching function.

Table 1.1: Airborne Sound Insulation

Minimum D_{nT} ($T_{mf,max}$),w (dB)		Activity noise in source room																				
		Primary School: classroom, general teaching areas, small group rooms	Post-primary School: classrooms, general teaching areas, seminar rooms, tutorial rooms, language laboratories.	Music	Lecture Rooms (<50 people)	Lecture Rooms (>50 people)	Study Room (individual study, withdrawal, remedial work, teacher preparation)	Libraries: Quiet Areas	Libraries: Resource	Science Laboratories	Design and Technology: Resistant materials, CADCAM areas, electronics/ control, textiles, food, graphics, design/ resources areas	Art Rooms	General Purpose rooms[7], Assembly halls, multi-purpose halls (drama, dining, PE, audio/visual presentations, assembly, occasional music)	Atria, circulation spaces	Indoor Sports Hall[7]	Interviewing/ counselling rooms, medical rooms	Dining Room[5]	Kitchens	Offices/ Staffroom	Toilets	Circulation Spaces
Noise tolerance in receiving room	Primary School: classroom, general teaching areas, small group rooms	45	n/a	n/a	n/a	n/a	40	n/a	45	n/a	n/a	n/a	55	45	n/a	40	n/a	55	45	45	55
	Post-primary School: classrooms, general teaching areas, seminar rooms, tutorial rooms, language laboratories.	n/a	45	55	45	45	40	40	45	45	55 45	45	55	45	55	40	55	55	45	45	55
	Music	n/a	45	55	45	45	40	40	45	45	55 45	45	55	45	55	40	55	55	45	45	55
	Lecture Rooms (<50 people)	n/a	45	55	45	45	40	40	45	45	55 45	45	55	45	55	40	55	55	45	45	55
	Lecture Rooms (>50 people)	n/a	50	60	50	50	45	45	50	50	55 50	50	55	50	55	45	55	55	50	50	55
	Study Room (individual study, withdrawal, remedial work, teacher preparation)	45	45	55	45	45	40	40	45	45	55 45	45	55	45	55	40	55	55	45	45	55
	Libraries: quiet areas	n/a	45	55	45	45	40	40	45	45	55 45	45	55	45	55	40	55	55	45	45	55
	Libraries: resource areas	40	40	55	40	40	35	35	40	40	50 40	40	50	40	50	35	50	50	40	40	50
	Science Laboratories	n/a	40	55	40	40	35	35	40	40	50 40	40	50	40	50	35	50	50	40	40	50
	Design and Technology: Resistant materials, CADCAM areas, electronics/ control, textiles, food, graphics, design/ resources areas	n/a	35 40	55	35 40	35 40	30 35	30 35	35 40	35 40	45 35 50 40	35 40	45 50	35 40	45 50	30 35	45 50	45 50	35 40	35 40	45 50
	Art Rooms	n/a	40	55	40	40	35	35	40	40	50 40	40	50	40	50	35	50	50	40	40	50
	General Purpose rooms[7], Assembly halls, multi-purpose halls (drama, dining, PE, audio/visual presentations, assembly, occasional music)	45	45	55	45	45	40	40	45	45	55 45	45	55	45	55	40	55	55	45	45	55
	Atria, circulation spaces used by students	40	40	55	40	40	35	35	40	40	50 40	40	50	40	50	35	50	50	40	40	50
	Indoor Sports Hall[7]	n/a	40	55	40	40	35	35	40	40	50 40	40	50	40	50	35	50	50	40	40	50
	Interviewing/ counselling rooms, medical rooms	45	45	55	45	45	40	40	45	45	55 45	45	55	45	55	40	55	55	45	45	55
	Dining Room[5]	n/a	35	55	35	35	30	30	35	35	45 35	35	45	35	45	30	45	45	35	35	45
	Kitchens	35	35	55	35	35	30	30	35	35	45 35	35	45	35	45	30	45	45	35	35	45
	Offices/ Staffroom	40	40	55	40	40	35	35	40	40	50 40	40	50	40	50	35	50	50	40	40	50
	Toilets	35	35	55	35	35	30	30	35	35	45 35	35	45	35	45	30	45	45	35	35	45
	Circulation Spaces	35	35	55	35	35	30	30	35	35	45 35	35	45	35	45	30	45	45	35	35	45

Notes on Table 1.1

1. Each value in the table is the minimum required to comply with the guideline. A value of 55 dB D_{nT} ($T_{mf,max}$),w between two music room practice rooms will not mean that the music will be inaudible between the rooms; in many cases, particularly if brass or percussion instruments are played, a high value is desirable.
2. Where values greater than 55dB D_{nT} ($T_{mf,max}$),w are required it is advisable to separate the rooms using acoustically less sensitive areas such as corridors and storerooms.
3. It is recommended that music rooms should not be placed adjacent to design and technology spaces or art rooms.
4. These values of D_{nT} ($T_{mf,max}$),w include the effects of glazing, doors and other weaknesses in the partition. In general, normal (non acoustic) doors provide much less sound insulation than the surrounding walls and reduce the overall D_{nT} ($T_{mf,max}$),w of the wall considerably, particularly for values above 35 dB D_{nT} ($T_{mf,max}$),w. Therefore, doors should not generally be installed in partitions between spaces requiring values above 35 dB D_{nT} ($T_{mf,max}$),w unless acoustic doors, door lobbies, or double doors with an airspace are used.
5. Dedicated dining rooms only, dining functions of a General Purpose room, as described in post primary school design guidelines TGD 023, should comply with the airborne sound insulation levels for a General Purpose room.
6. For explanation on measurement unit, DnT (Tmf,max),w (dB), refer to BB93 Appendix 3: Basic Principles of Sound Insulation.
7. Movable partitions sub-dividing the Sports Halls or large GP Rooms should have a minimum Airborne Sound Insulation of 20dB.

1.5 Airborne sound insulation between circulation spaces and other spaces used by students

The objective is to attenuate airborne sound transmitted between circulation spaces (e.g. corridors, stairwells) and other spaces used by students

Table 1.2 contains the required minimum airborne sound insulation for the separating wall construction and any doorsets in the wall. The airborne sound insulation for walls and doorsets is quoted in terms of the weighted sound reduction index, Rw, which is measured in the laboratory. The performance standard is set using a laboratory measurement because of the difficulty in accurately measuring the airborne sound insulation between rooms and corridors, or rooms and stairwells in the field. Therefore it is crucial that the airborne sound insulation of the wall and/ or doorset is not compromised by flanking sound transmission, e.g. sound transmission across the junction between the ceiling and corridor wall.

Table 1.2: Performance standards for airborne sound insulation between circulation spaces and other spaces used by students

Type of space used by students	**Maximum R_W (dB)**	
	Wall including any glazing	Doorset[1]
All spaces except music rooms	**40**	**30**
Music Rooms[2]	**45**	**35**

Notes on Table 1.2

1. The R_W ratings are for the doorset alone. Manufacturers sometimes provide doorset sound insulation data as a combined rating for the wall and doorset where the R_W refers to the performance of an ≈10m² high performance wall containing the doorset. This is not appropriate as it gives higher figures than the R_W of the doorset itself.
2. Special design advice may be recommended.
3. For explanation of the measurement units, R_W (dB), refer to BB93 Appendix 3: Basic Principles of Sound Insulation.

1.6 Impact sound insulation of floors

The objective is to attenuate impact sound (e.g. footsteps) transmitted into spaces below via the floor. Table 1.3 contains the recommended maximum weighted BB93 standardized impact sound pressure level, $L'_{nT(Tmf,max),}w$, for receiving rooms of different types and uses.

Table 1.3: Performance Standard for Impact Sound Insulation of Floors

Type of room (receiving room)	Maximum weighted BB93 standardized impact sound level, $L'_{nT(Tmf,max),}w$ (dB)
Primary School: classroom, general teaching areas, small group rooms	**60**
Post-Primary School: classrooms, general teaching areas, seminar rooms, tutorial rooms, language laboratories.	**60**
Music	**55**
Lecture Rooms (less than 50 people)	**60**
Lecture Rooms (greater than 50 people)	**55**
Study Room (individual study, withdrawal, remedial work, teacher preparation)	**60**
Libraries	**60**
Science Laboratories	**65**
Design and Technology: Resistant materials, CADCAM areas Electronics/ control, textiles, food, graphics, design/ resources areas	**65** **60**
Art Rooms	**60**
General Purpose rooms, Assembly halls, multi-purpose halls (drama, dining, PE, audio/visual presentations, assembly, occasional music)	**60**
Atria, circulation spaces used by students	**65**
Indoor Sports Hall	**65**
Interviewing/ counselling rooms, medical rooms	**60**
Dining Room[2]	**65**
Kitchens	**65**
Offices/ Staffroom	**65**
Toilets	**65**
Circulation Spaces	**65**

1. For explanation on measurement unit, $L'_{nT(Tmf,max),}w$ (dB), refer to BB93 Appendix 3: Basic Principles of Sound Insulation.
2. Dedicated dining rooms only, dining functions of a General Purpose room, as described in post primary school design guidelines TGD 023, should comply with the performance standard for impact sound insulation of floors in a General Purpose room.

1.7 Reverberation in teaching and study spaces

The objective is to provide suitable reverberation times for (a) clear communication for speech between teacher and student, and between students, in teaching and study spaces and (b) music teaching and performance.

Table 1.4 contains the required mid-frequency reverberation times for rooms which are finished but unoccupied and unfurnished. The reverberation time is quoted in terms of the mid-frequency reverberation time T_{mf}, the arithmetic average of the reverberation times in the 500 Hz, 1 kHz and 2 kHz octave bands.

Sound absorption from pin boards and notice boards can change when they are covered up or painted. Absorption coefficients for pin boards and notice boards used in design calculations should be for fully covered or painted boards, as appropriate. If these data are not available then

the absorption coefficient for the board area used in the design calculation should be the absorption coefficient of the wall to which the board is attached.

Table 1.4: Performance Standard for Reverberation in various rooms

Type of room	Mid-frequency reverberation time, $T_{mf}1$ (seconds), in finished but unoccupied and unfurnished room
Primary School: classroom, general teaching areas, small group rooms	**<0.6**
Secondary School: classrooms, general teaching areas, seminar rooms, tutorial rooms, language laboratories.	**<0.8**
Music	**<1.0**
Lecture Rooms (less than 50 people)	**<0.8**
Lecture Rooms (greater than 50 people)	**<1.0**
Study Room (individual study, withdrawal, remedial work, teacher preparation)	**<0.8**
Libraries	**<1.0**
Science Laboratories	**<0.8**
Design and Technology: Resistant materials, CADCAM areas, electronics/ control, textiles, food, graphics, design/ resources areas	**<0.8**
Art Rooms	**<0.8**
General Purpose rooms, Assembly halls, multi-purpose halls (drama, dining, PE, audio/visual presentations, assembly, occasional music) (≤200.0m²)	**0.8 – 1.2**
Atria, circulation spaces used by students	**<1.5**
Indoor Sports Hall[2], General Purpose rooms[2] (>200 m² & ≤406m²)	**<1.5**
Indoor Sports Hall[2] (>406m²)	**<2.0**
Interviewing/ counselling rooms, medical rooms	**<0.8**
Dining Room[3]	**<1.0**
Kitchens	**<1.5**
Offices/ Staffroom	**<1.0**
Toilets	**<1.5**
Circulation Spaces	**Amount required should be calculated according to Approved Document E[(7)], Section 7 of BB93.**

1. For explanation on measurement unit, $T_{mf}1$ (seconds), refer to BB93 Appendix 2: Basic Principles of Room Acoustics.
2. Where Indoor Sports Halls and General Purpose rooms are to be sub-divided then the reverberation time for the hall when sub-divided should be used for each space i.e. a 400m² hall divided into two 200m² spaces the reverberation time for the 200m² space should be used.
3. Dedicated dining rooms only, dining functions of a General Purpose room, as described in post primary school design guidelines TGD 023, should comply with the performance standard for reverberation in a General Purpose room.

1.8 Sound absorption in corridors, entrance halls and stairwells

The objective is to absorb sound in corridors, entrance halls and stairwells so that it does not interfere with teaching and study activities in adjacent rooms.

The requirement is to provide sound absorption in corridors, entrance halls and stairwells. The amount of additional absorption should cover a specified area with an absorber of an

appropriate class that has been rated according to BS EN ISO 11654:1997 Acoustics; Sound absorbers for use in buildings; Rating of sound absorption.

For entrance halls, corridors or hallways cover an area equal to or greater than the floor area, with a Class C absorber or better. It will normally be convenient to cover the ceiling area with the additional absorption.

For stairwells or stair enclosures, calculate the combined area of the stair treads, the upper surface of the intermediate landings, the upper surface of the landings (excluding ground floor) and the ceiling area on the top floor. Either cover at least an area equal to this calculated area with a Class D absorber or better, or cover an area equal to at least 50% of this calculated area with a Class C absorber or better. The absorptive material should be equally distributed between all floor levels. It will normally be convenient to cover the underside of intermediate landings, the underside of the other landings, and the ceiling area on the top floor.

The sound absorption in corridors, entrance halls and stairwells can generally be satisfied by the use of proprietary acoustic ceiling. However, the absorption material can be applied to any surface that faces into the space.

1.9 Testing/ Demonstrating Compliance

To ensure that the performance standards set out in this document are met acoustic testing should be included in the building contract. In practice, the performance of the completed school is strongly influenced by workmanship on site. If the design calculations, specifications and detailing are correct, the most likely causes of failure to meet the performance standards required will be poor workmanship, product substitution (authorised or not pointed out by suppliers) and site design changes. Therefore, acoustic testing is required as a further quality control measure.
Refer to BB93 Section 1.3 for acoustic testing procedures to be used to demonstrate compliance with the performance standards set out in this document.

1.10 Further Reference

For further information, testing procedures, etc., please consult Building Bulletin 93 (BB93), Acoustic Design of Schools, Architects and Building Branch, London: Stationery Office, United Kingdom, ISBN 0 11 2711057. Also available for download at:

https://www.education.gov.uk/publications/standard/publicationDetail/Page1/BB93