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agus Scileanna
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Acoustic Performance in New Primary & Post Primary School Buildings

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1. BACKGROUND TO LATEST REVISIONS

The Department of Education and Skills (DoES) has an ongoing policy of updating and improving its suite of Technical Guidance Documents / School Design Guides (TGDs/SDGs) for schools with a view to offering better guidance to school authorities and Design Teams. Since the introduction of this guidance document in February 2013, the DoES has been monitoring its implementation on projects and reviewing its application in schools. As part of this review process it has also engaged with design teams and reviewed recent developments in the field of acoustics, including international best practice, with a view to identifying further improvements to the guidance contained in the document. This is what prompted the changes to the original document and this latest revision, i.e. Revision 1. All changes in Revision 1 compared to the original document are in red text.

Note it is acknowledged that other TGDs outline certain acoustic design criteria for various aspects of school design. It should be noted that the criteria and guidance outlined in this document supersedes acoustic guidance given in previously issued TGDs and therefore should be given due consideration in the design of educational facilities.

2. ACOUSTIC PERFORMANCE IN NEW SCHOOLS

2.1 Performance Standards

The overall objective of the performance standards in this document is to provide acoustic conditions in schools that:

- Facilitate clear communication of speech between teacher and student, and between students,
- Do not interfere with study activities.

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

- Rain Noise,
- Indoor Ambient Noise Levels,
- Airborne Sound Insulation between Spaces,
- Airborne Sound Insulation between Circulation Spaces and Other Spaces used by Students,
- Impact Sound Insulation of Floors,
- Reverberation in Various Spaces,
- Sound Absorption in Corridors, Entrance Halls and Stairwells.

2.2 Rain Noise

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

Due to the fluctuating nature of rainfall; laboratory test data on the roof element is required. The standard ISO 10140-1:2010/Amd 2:2014 details the test method for determining rainfall noise on building elements including a definition for rain in terms of rainfall rate, drop diameter and fall velocity. The Indoor Ambient Noise Levels (IANL) must not exceed a 30dB limit above Table 1.0 levels at the standardised heavy rainfall rate of 40mm/hr. This 30dB allowance above the Table 1.0 levels is a relaxation on the previously recommended allowance of 20dB to take cognisance of the more typical rainfall rate in Ireland (~20mm/hr)".

2.3 Indoor Ambient Noise Levels in Unoccupied Spaces

The objective is to provide suitable indoor ambient noise levels for;

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

2.3.1 Sites

External sources outside the school premises include, but are not limited to, noise from road, rail and air traffic, industrial and commercial premises.

Due regard to Indoor Ambient Noise Level (IANL) 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:
- More than 250,000 inhabitants
- Places near major roads which have more than six million vehicle passages a year
- Major railways which have more than 60 000 train passages per year
- Major airports
- These maps are available at: https://gis.epa.ie/EPAMaps/

2.3.2 Building Services

Noise from services may include those from heating, mechanical extract ventilation systems, boiler plant, etc. If a room is mechanically ventilated, the plant should be assumed to be running at its maximum duty.

- The following extracts from Department of Education & Skills (DoES) technical guidance documents TGD-002 First Edition, February 2004: Mechanical & Electrical Building Services Engineering Guidelines for Primary School Buildings, Section 3.6 and TGD 003 First Edition, February 2004: Mechanical & Electrical Building Services Engineering Guidelines for Post Primary School Buildings, Section 3.6 should be carefully noted.
- The design and installation of the Building Services Systems shall ensure that their operation will not interfere with the schools teaching function.
- Mechanical services can contribute to overall noise levels, and this aspect shall receive particular attention at design stage through system design and equipment selection etc., acoustic attenuation should not be necessary through appropriate design. Heating systems for Physical Education Hall shall be carefully selected to ensure they meet the background noise criteria for this area.

2.3.3 Criteria for Indoor Ambient Noise Level

The criteria for Indoor Ambient Noise Level (IANL) for the various room types are detailed in Table 1.0 below.

The IANL includes noise contributions from:

- External sources outside the school premises (including, but not limited to, noise from road, rail and air traffic, industrial and commercial premises). Where it has been decided that the location for the school site is within a zone in excess of 50dB Lden on the relevant Noise Map, then the advice of an acoustic consultant must be obtained as part of the design process. To meet the standards in Table 1.0 below, it may be necessary to undertake acoustic testing of the site and external environment and to implement mitigating measures as outlined below through the building design. With regard to noise infiltration from external sources, in all cases designers should be cognizant of ambient noise levels around the particular site and employ cost neutral measures such as careful siting of the building within the overall site area available, using boundary treatments, landscaping measures, car parking and play areas as acoustic buffers. The location of the teaching spaces within the building relative to the noise source, with care in orientation of windows and openings, should all attempt to mitigate noise infiltration. Where noise surveys show that the external noise level at the location of the proposed window is no more than 16 dB (for single sided ventilation) or 20dB (for cross-ventilation) above the limits in Table 1.0 below for Indoor Ambient Noise Levels (IANL), opening windows and vents are deemed to satisfy the acoustic requirement, provided the IANLs inside the room with the windows closed do not exceed the IANLs limits given in Table 1.0 below. Single sided ventilation is defined as where air enters and exhausts from the same façade; double-sided ventilation is where air intake and exhaust are on different room elevations.

- Building services (e.g., ventilation systems, plant, drainage etc.). If a room is naturally ventilated, the IANL is calculated and measured with ventilators or windows open as required to provide ventilation as described in section 1.1.3. If a room is mechanically ventilated or cooled, the plant should be assumed to be running at its normal operating duty.
- Actuator and damper noise.

IANL excludes noise contributions from:

- Teaching activities within the school building. This includes noise from staff, students, M&E services and equipment within the building or in the playground. Noise from adjacent spaces is addressed by the Airborne (Sections 2.4, 2.5) and Impact Sound Insulation (Section 2.6) requirements.
- Equipment used in the spaces (e.g. machine tools, drills, lathes, band-saws, sander, grinding wheel, welder, local mechanical extract ventilation systems, compressors, computers, printers, overhead projectors, etc.). However these noise sources should be considered in the design.

Type of Room	Upper Limit for IANL, L'_{Aeq},30min (dB)
Primary School: general teaching areas: classrooms, Special Education Tuition rooms, Multi-Purpose room	35
Post-Primary School: general teaching areas: classrooms, inter-linked classrooms, pastoral offices, special tuition rooms, Multi-media rooms	35
Music	35
Libraries	35
Science Laboratories	35
Construction Studies/Engineering/Technology, Textiles, Home Economics, Design & Comm./Tech Graphics	40
Art/Craft Rooms	40
General Purpose Room[1], Multi-Use/PE Hall[1]	35
Atria, circulation spaces	45
Kitchens	50
Offices / Staffroom	40
Toilets	50
Circulation Spaces	45

Table 1.0: Recommended Criteria for Indoor Ambient Noise Levels

Notes;

1. General Purpose Rooms in primary schools and General Purposes Rooms and Multi-Use/PE Halls in Post-Primary schools, being the largest spaces available in new schools, are multi-functional spaces and used for activities such as dining, Physical Education (not just Sports), examinations, assembly, performing plays, dance and concerts. In such multi-functional spaces the Design Team should design, with particular attention to heating installation and any mechanical extract ventilation services, to the lowest indoor ambient noise level for which the space will be used in practice, i.e. 35dB $L_{Aeq,30min.}$
2. In line with BB93:2015 Table 2, a 5dB relaxation of the above Table 1.0 values will be acceptable in buildings which are to be naturally ventilated.
3. For explanation of the measurement units, $L_{Aeq,30min}$ (dB), refer to BB93:2003 edition, Appendix 1: Basic Concepts and Units.

2.4 Airborne Sound Insulation between Spaces

The objective is to attenuate (i.e. diminish or lessen) airborne sound transmitted between spaces through walls and floors. Table 1.1 below 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, and between partitions and other building elements, 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 the design and installation of the building services does not infringe on required standards. In the design and installation of the building services it is critical to ensure that their operation does not interfere with the schools teaching function. Note the criteria in Table 1.1 relate to partitions that do not contain doors. Guidance on doors is detailed in Section 2.5 of this document.

Minimum DnT,w (dB)		**Source Room**												
		Primary School: general teaching areas, classroom, Special Education Tuition rooms, Multi-Purpose room	Post-primary School: general teaching areas, classrooms, inter-linked classrooms, pastoral offices, special tuition rooms, Multi-media, Meditation, Meeting	Music	Libraries	Science Laboratories	Construction Studies, Engineering, Technology	Textiles, Home Economics, design & Comm./Tech Graphics	Art/Craft Rooms	General Purpose Room[3], PE Hall[3]	Atria, circulation spaces	Kitchens	Office / Staffroom	Toilets
Receiving Room	Primary School: general teaching areas, classroom, Special Education Tuition rooms, Multi-Purpose room	45	n/a	n/a	40	n/a	n/a	n/a	n/a	55	45	n/a	45	45
	Post-primary School: general teaching areas, classrooms, inter-linked classrooms, pastoral offices, special tuition rooms, Multi-media, Meditation, Meeting.	n/a	45	55	40	45	55	45	45	55	45	55	45	45
	Music		45	55	45	45	55	45	45	55	45	55	45	45
	Libraries	45	45	55	35	45	55	45	45	55	45	55	45	45
	Science Laboratories	n/a	40	55	35	40	50	40	40	50	40	50	40	40
	Construction Studies, Engineering, Technology	n/a	35	55	30	35	45	35	35	45	35	45	35	35
	Textiles, Home Economics, design & Comm./Tech Graphics	n/a	40	55	35	40	50	40	40	50	40	50	40	40
	Art/Craft Rooms	n/a	40	55	35	40	50	40	40	50	40	50	40	40
	General Purpose Room3, Multi-Use Hall3, PE Hall3	45	45	55	40	45	55	45	45	45	45	45	40	35
	Atria, circulation spaces	35	35	45	30	35	45	35	35	45	35	45	40	35
	Kitchens		35	45	30	35	45	35	35	45	35	35	35	35
	Office / Staffroom	40	40	55	35	40	50	40	40	50	40	50	40	40
	Toilets	35	35	35	30	35	45	35	35	45	35	35	35	35

Table 1.1: Airborne Sound Insulation

Notes;

1. Each value in the table is the minimum required to comply with the guideline. A value of 55dB $D_{nT,w}$ 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. It is recommended that Music rooms should not be placed adjacent to noise generating spaces such as General Purpose Area, PE, Construction Studies, Engineering or Technology. Also to minimise disturbance caused by sound emerging from Music rooms consider utilising stores and toilets as acoustic buffers to any adjacent teaching spaces.
3. Movable folding screens sub-dividing the Multi-Use Hall, or Sports Hall, or large GP Rooms should have a minimum Airborne Sound Insulation of 20dB $D_{nT,w}$.
4. For explanation of the measurement units $D_{nT,w}$ (dB), refer to BB93:2003 edition, Appendix 3: Basic Principles of Sound Insulation.

2.5 Airborne Sound Insulation between Circulation Spaces & 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 below 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.

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

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

Notes;

1. The RW ratings are for the doorset alone. Manufacturers sometimes provide doorset sound insulation data as a combined rating for the wall and doorset where the RW refers to the performance of an ≈10m² high performance wall containing the doorset. This is not appropriate as it gives higher figures than the RW of the doorset itself.
2. Special design advice may be recommended.
3. For explanation of the measurement units, RW (dB), refer to BB93:2003 edition, Appendix: Basic Principles of Sound Insulation.

2.6 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 below contains the recommended maximum weighted standardized impact sound pressure level, $L'_{nT(Tmf,max)}w$, for receiving rooms of different types and uses.

Type of room (receiving room)	Maximum Impact Sound Pressure Level, $L'_{nT,w}$ (dB)
Primary School: general teaching areas, classroom, Special Education Tuition rooms, Multi-Purpose room	60
Post-Primary School: general teaching areas, classrooms, inter-linked classrooms, pastoral offices, special tuition rooms, Multi-media, Meditation, Meeting	60
Music	55
Libraries	60
Science Laboratories	65
Construction Studies, Engineering, Technology	65
Textiles, Home Economics, Design & Comm./ Tech Graphics	60
Art/Craft Rooms	60
General Purpose Room, Multi-Use Hall, PE Hall	60
Atria, circulation spaces	65
Interviewing/ counselling rooms, medical rooms	60
Kitchens	65
Offices/ Staffroom	65
Toilets	65

Table 1.3: Performance Standard for Impact Sound Insulation of Floors

Notes;

1. For explanation on measurement unit, $L'_{nT,w}$ (dB), refer to BB93:2003 edition, Appendix 3: Basic Principles of Sound Insulation.

2.7 Reverberation in Teaching & 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 below contains the required mid-frequency reverberation times for rooms which are finished, furnished for normal use but unoccupied. The reverberation time is quoted in terms of the mid-frequency reverberation time Tmf, 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.

Type of room	Mid-frequency reverberation time, T_{mf} [1] (seconds), in finished, normally furnished but unoccupied spaces.
Primary School: general teaching areas, classroom, Special Education Tuition rooms, Multi-Purpose room	≤0.6
Post-Primary School: general teaching areas, classrooms, inter-linked classrooms, pastoral offices, special tuition rooms, Multi-media, Meditation, Meeting	≤0.8
Music	≤1.0
Libraries	≤1.0
Science Laboratories	≤0.8
Construction Studies, Engineering, Technology	≤0.8
Textiles, Home Economics, Design & Comm./ Tech Graphics	≤0.8
Art/Craft Rooms	≤0.8
General Purpose Room, Multi-Use Hall, PE	≤1.5
Atria, circulation spaces	≤1.5
Kitchens	≤1.5
Offices/ Staffroom	≤1.0
Toilets	≤1.5

Table1.4: Performance Standard for Reverberation in various rooms

Notes:

1. For explanation on measurement unit, Tmf (seconds), refer to BB93:2003 edition, Appendix 2: Basic Principles of Room Acoustics.

2.8 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 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 at least 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 ceilings. However, the absorption material can be applied to any surface that faces into the space.

2.9 Testing & Demonstrating Compliance

To ensure that the performance standards set out in this document are met acoustic testing needs to be included in the scope of service of the design team.

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 undertaken by an independent specialist acoustic consultant reporting to the Architect/ER is required as a further quality control measure.

Testing should be carried out by a Specialist Acoustic Consultant in accordance with the testing and reporting procedures described in the Association of Noise Consultants publication 'Good Practice Guide – Acoustic Testing of Schools' Version 1.2, July 2011. The updated version will be published jointly by the Association of Noise Consultants (ANC) and Institute of acoustics (IOA), as Acoustics of schools: *a design guide*.

In addition the following test standards, including any subsequent updates, should apply:

- ISO 16283-1:2014 'Acoustics -- Field measurement of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation'.
- ISO 140-7:1998 'Acoustics. Measurement of sound insulation in buildings and of building elements. Field measurements of impact sound insulation of floors';
- ISO 3382-1:2009 'Acoustics -- Measurement of room acoustic parameters -- Part 1: Performance spaces'.
- ISO 3382-2:2008 'Acoustics -- Measurement of room acoustic parameters -- Part 2: Reverberation time in ordinary rooms'.
- ISO 16032:2004 'Acoustics. Measurement of sound pressure level from service equipment in buildings. Engineering method'.

Following references to be noted:

- ISO 10140-1:2010/Amd 2:2014 Acoustic - Laboratory measurement of sound insulation of building elements - Part 1: Application rules for specific products AMENDMENT 2: Rainfall sound.
- ISO 717-1:2013 'Acoustics -- Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation'.
- ISO 717-2:2013 'Acoustics. Rating of sound insulation in buildings and of building elements. Part 2 Impact sound insulation'.
- ISO 18233:2006 'Acoustics -- Application of new measurement methods in building and room acoustics'.
- Further Reference.

2.10 Further References

For further information, testing procedures, etc., please consult Department for Education UK Building Bulletin 93, February 2015: Acoustic design of schools: performance standards.

Available for download at:

https://www.gov.uk/government/publications/bb93-acoustic-design-of-schools-performance-standards