# School Acoustics and BB93

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## Introduction

Since the publication of Building Bulletin 93 (BB93) in 2003 and the incorporation of the document into Approved Document E (ADE) of the Building Regulations in 2006, there has been a requirement for schools to be designed and built to achieve a defined acoustic standard. Although pre-completion acoustic testing is recommended by BB93, this has never been mandatory. As a result, school developers and Building Control bodies have often chosen not to have the finished schools tested.

Recently, damning research published by the National Deaf Children's Society has shown that only 11% of local authorities who had built new schools since the introduction of BB93 could show that they had complied with the standards, without derogating from the specified minimum standards in some way.

## The Requirements

The minimum acoustic standards detailed in BB93 specify the following;

- maximum unoccupied ambient noise levels for each teaching space.

  The value of the maximum ambient noise permitted depends on the subjects taught in a particular space. In order to ensure that the maximum unoccupied noise levels for each teaching space are not too high, external noise levels at the school site need to be measured prior to the design of the external façades, to ensure that noise break-in does not exceed the target levels. In addition the ventilation system needs to be selected to ensure that it does not introduce noise above the required level.

- either a maximum value, or a range, for the reverberation time in each teaching space.

  The value of the reverberation time depends on the subjects taught in a particular space. The reverberation time in finished teaching spaces can be estimated by considering the room geometry and the noise absorbency data of the room surface finishes. Where predicted reverberation times are not within the required range, alternative room finishes may be specified to alter the absorbency and achieve the required reverberation times.

- the minimum sound insulation between adjacent teaching spaces.
  The minimum sound insulation required depends on the likely noise production in a room on one side of a wall or floor, and noise sensitivity of the adjacent teaching space on the other side. To ensure that the sound-insulation between adjacent spaces is adequate the in-situ performance of the separating walls and floors between classrooms must be calculated. It should be noted that the specification is given in terms of in -situ performance, so it is important to include the effects of 'flanking transmission' where sound 'leaks' around the main separating element, either by other paths through the structure, or by airborne paths around the separating element. Room volumes and reverberation times will also have an effect on the in-situ performance of walls and floors.

  In addition to the requirements of BB93, local authorities may wish to build sustainable schools to the BREEAM sustainable building standards. In this case up to three credits may be gained by attaining particular acoustic standards. These are as follows;

- 1 credit for fully complying with the requirements of BB93
- 1 credit for increasing the sound insulation of music classrooms (in secondary schools) or multi-purpose halls (in primary schools) by 5dB above the minimum standard specified in BB93.
- 1 credit for demonstrating that the noise in classrooms due to rainfall on the roof is not likely to exceed the maximum internal ambient noise levels specified in BB93.

## Some pitfalls

Although BB93 is written in such a way as to be accessible to people without specialist acoustic qualifications, it does not attempt to offer solutions to any but the most straight - forward of acoustic design problems. A few of the more common pitfalls encountered in school designs are detailed below (please note that this is not intended to be an exhaustive list and many other common faults have been omitted);

- Locating high noise-activity rooms adjacent to noise sensitive rooms

  BB93 specifies the required sound-insulation between rooms depending on their sensitivity to noise and the likely noise generation of the adjacent room. For the highest noise activity rooms a very high sound insulation of 55dB or 60 dB $D_{nT(Tmf,max),w}$ to adjacent rooms is required. Many architects and designers fail to appreciate how onerous achieving such a high sound insulation will be, and BB93 gives no indication of appropriate constructions. A high specification separating partition is likely to be required and in addition all flanking walls and floors are also likely to need substantial treatments in order to achieve the required sound insulation. The best approach is to use store-rooms, circulation spaces, or other buffer zones around very high noise activity classrooms to eliminate the need for such high sound-insulation constructions; however, the layout of rooms is often fixed before an acoustic professional is consulted. This problem occurs most often with classrooms adjacent to music rooms, and in the worst cases with music rooms adjacent to ensemble rooms or drama studios.

- Underestimating the ambient noise climate

  Assumptions are often made that natural ventilation through open windows will be appropriate for schools without considering that the noise break-in from outside is likely to be too high. For virtually all urban areas and all areas near to major transport routes ambient outdoor noise levels are likely to be too high to permit ventilation through open windows without considering some form of acoustic attenuation to the inlet, either by specialist opening lights, shielding or restricting the open area. Building Bulletin 101 suggests that derogation from BB93 by increasing internal levels by 5dB may be appropriate for naturally ventilated systems during 'rapid' ventilation; ***however the levels of BB93 must still be maintained during 'normal' background ventilation***. For mechanically ventilated systems the levels of BB93 must be maintained at all times.

- Not considering reverberation

  For many secondary school classrooms of a typical shape fitted with carpets and an acoustically absorbent lay-in-grid tile ceiling, the reverberation time will achieve the required criterion of BB93. This can lead to a false sense of security with a failure to appreciate the effects of deviations from the 'typical' classroom. In particular; unusual room geometry, large volume rooms with high ceilings, hard floor coverings, or omission of acoustic ceiling tiles for aesthetic reasons, can result in the required reverberation criterion not being achieved. This problem occurs most often with

primary school and nursery classrooms, which have a more stringent reverberation criterion than secondary school classrooms, and with sports halls and multi-use halls. The simple calculations for reverberation time described in BB93 are not reliable for rooms with a large volume or unusual shape and in these cases a numerical computer simulation of reverberation using ray-tracing software may be requ ired for an accurate prediction and to determine the most appropriate surface finishes.

- Not considering rain noise

  Although BB93 does not set a specific criterion for rainfall noise this is largely due to the lack of rainfall noise data for roof constructions when BB93 was written. BB93 does state that rainfall noise should be considered during the design with whatever data is available. Over the last few years extensive testing has been carried out on most of the major manufacturers roofing systems which allow typical internal noise levels due to rainfall to be calculated. Rain noise can be a particular problem where lightweight roofs are installed over high-volume reverberant spaces such as sports and assembly halls, particularly where there is no ceiling planned below the roof liner sheet. In these cases it is important that an appropriate roof construction is selected at the design stage to avoid the space being unusable for teaching during periods of heavy rainfall.

- Poor construction quality control

  Whilst this is not strictly a design issue, the acoustic performance of elements and junction details is critically dependent on the quality of their construction. It is vital that a high standard of construction quality is maintained throughout the build. This is particularly important where some of the higher sound-insulation specified in BB93 have been included in the design, as the slightest deviation can result in the failure of these systems.

## Passing the tests

All too often failures to meet the acoustic standards are the result of considering acoustics too late in the design process after many decisions about location, layout, finishes and aesthetics have been made. Where attempts are made to 'bolt-on' acoustic performance to a practically finished design this can often lead to expensive and aesthetically unappealing 'remedial' treatments which are subsequently omitted from the final design by derogating from BB93 as this is seen as a lower cost option during 'value engineering' exercises.

Passing the acoustic commissioning tests to achieve the minimum criteria of BB93 is accomplished most easily by a holistic approach, considering the acoustic implications of design decisions right from the very start of the project, and continuing through to completion, with strict monitoring and control of detailing and construction quality. A phased testing regime throughout the build programme will also ensure that where acoustic criteria are not being met suitable changes can be made at an early stage to ensure compliance by the time the project reaches completion.

**For further information please contact:**
**PDA Ltd**, Alder House, Willow Tree Park, Booths Lane, Lymm,
Cheshire WA13 0GH Tel: 01925 759380

Or visit
**http://www.pdaltd.com**