SCHOOL MUSIC ROOMS - DESIGNING BEYOND BB93

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1. INTRODUCTION

The revised Approved Document E of the Building Regulations came into force in July 2003. One of the new requirements is that, for the first time, new and refurbished schools have to meet strict standards for noise levels, sound insulation and room acoustics. These standards are set out in Section 1 of the Department for Education and Skills (DfES) Building Bulletin 93 “Acoustic Design of Schools”. [1]

As part of the Building Regulations, BB93 must by definition be only a minimum standard. Like any other minimum standard this can not in itself be a blueprint for acoustic excellence. A previous paper [2] identified that in some cases higher standards of sound insulation could and should be applied. Particular cases include music practice rooms where drums and amplified instruments are used, studios and auditoria. Since July 2003 we have become involved in a number of such projects and this paper discusses some of the cases in which simply complying with BB93 is not appropriate.

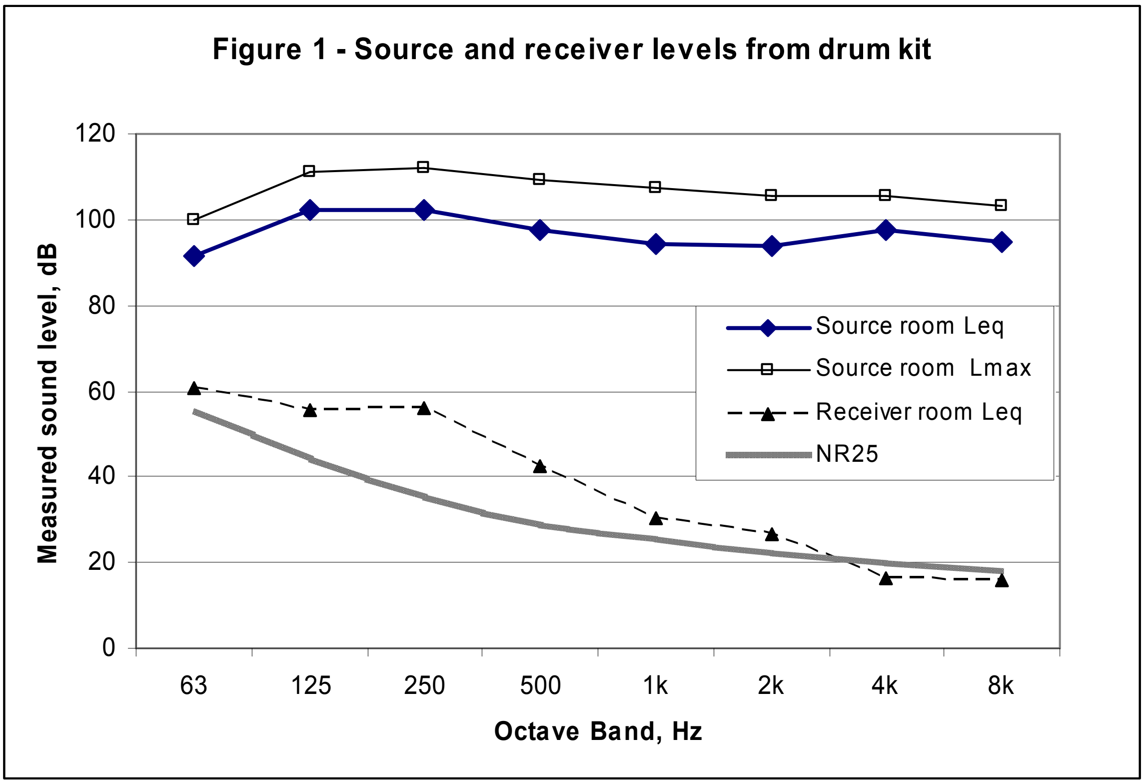
As acoustics consultants we may be the only members of the design team with any previous experience of auditorium and studio design. We sometimes find ourselves faced with an initial design which we know will not work for reasons which have little to do with acoustics. Common examples are school theatres with inadequate stage space, studios which are simply the wrong size for the intended use, and such obvious but often-overlooked matters as music rooms and halls with no access for a grand piano. This paper therefore also sets out a few guidelines on the operational, rather than the acoustic, aspects of performance areas for schools.

2. SOUND INSULATION FOR MUSIC ROOMS

The sound insulation criteria in BB93 for music rooms were derived from the experience of acoustics consultants over the previous twenty years. It was generally agreed that a certain amount of audibility between practice rooms is acceptable and that imposing unduly high standards could impose unrealistically high construction costs. A small relaxation was generally allowed from the generally accepted standards for practice rooms in music colleges, as summarised in the definitive paper by John Miller [3].

All of these standards were, however, derived from experience with classical musical instruments. Some consideration was given to the higher standards of isolation required for percussion rooms but it was considered unrealistic to impose this standard on all practice rooms. One matter that perhaps did not receive due consideration was the likely expansion in teaching of Rock and Pop music and the consequent use of practice rooms for drum kits and amplified instruments, particularly bass guitars. Typically such instruments can generate noise levels well above those for which traditional practice rooms were designed.

We recently took measurements in a pair of large practice / group rooms also used for recording. These were built using lightweight floating “Box in box” constructions and achieved a measured weighted level difference (Dw) of 69 dB, significantly better than the 60 dB required to comply with BB93. We would normally expect this to be more than adequate but in fact, even with the background noise level artificially increased to NR25, the noise from a drum kit in one room gave rise to complaints that the adjacent room was unusable. The measured levels are summarised in Figure 1.



The average reverberant sound pressure level in the source room with the drum kit being played was 103.3 dB LAeq and 111.8 dB Lmax (fast), both measured over a 5-minute period. The RT was within the limits set by BB93. These are by no means unusual noise levels for drum lessons, and in a practice or recording session these levels can be kept up over half an hour or more. For lessons it might be argued that these levels would only be reached on a few occasions and that the Leq over 30 minutes would be 3-5 dB lower. The degree of intrusion on adjacent rooms is not, however, averaged over a session and we have found that complaints tend to arise if teachers find that noise from adjacent areas interferes with their lesson on several occasions even for a few seconds at a time.

Of course under Noise at Work legislation we would expect a drum teacher to wear ear protection, and we would recommend that students do the same. This advice may be taken seriously in some schools but in others, and in particularly in some Colleges of Further Education with large rock and pop music departments, both students and staff resist this idea. Of course, irrespective of the legislation on Noise at Work (which of course protects only teachers), as responsible designers we should not be encouraging generation of sound levels which could lead to hearing damage. We must also, however, bear in mind the need for some musicians to learn to play their instruments loudly. It is not unusual for professional performers in all types of music to wear ear-plugs while practicing and sometimes in performance, bearing in mind that the direct sound level affecting the player will be considerably higher than the level reaching the audience in a large auditorium.

Initially the problem in the case illustrated above was exacerbated by the ambient noise level (from the ventilation system) being much lower than specified. Although BB93 provides guidance on the use of constant noise to provide masking, this can not really be included as a requirement under

Building Regulations. However, even when the ambient level was artificially increased to the maximum permitted under BB93, the corresponding Leq in the receiver room was still well above the ambient level. We know that music sources are clearly audible at levels 10 - 15 dB below a steady ambient level, so these figures suggest that the separation between a drum room and any other noise-sensitive room should be of the order of 90 dB Rw to avoid annoyance or interference. This is difficult to achieve even with the dense floating concrete constructions of traditional commercial studios. The obvious solution for a school is to locate the drum room remote from the rest of the music accommodation. In some Colleges of Further Education, however, more than 50% of the music students play drums or equally loud instruments and we have to assume that any music room could experience these noise levels. It rapidly becomes impracticable to provide so many rooms remote from each other.

With drum kits, the problems tend to manifest themselves across the frequency spectrum, including the medium to high frequencies at which the performance of dry-lined structures generally exceeds that of masonry construction. Dense floating masonry studios are therefore not necessarily the answer. Neither is specifying sound insulation in terms of Rw + Ctr.

The only realistic solution for drums, therefore, may be to educate staff and pupils alike to work as much as possible at lower noise levels, using drum mutes, dampers or electronic drum pads. With amplified instruments (electric guitars etc) some control is always present in the form of the amplifier volume adjustment. Unfortunately, one of the characteristics of rock and pop music is that the performers do expect it to be loud and there is really a fundamental conflict between this and the avoidance of noise-induced hearing loss. There is a school of thought that, as responsible acousticians, we should use limited sound insulation as the means of discouraging playing at levels likely to damage hearing. This is convenient as limited sound insulation is in any case a natural result of the limited budgets and space available to most educational building projects.

Figure 2 - Measured Leq for various instruments

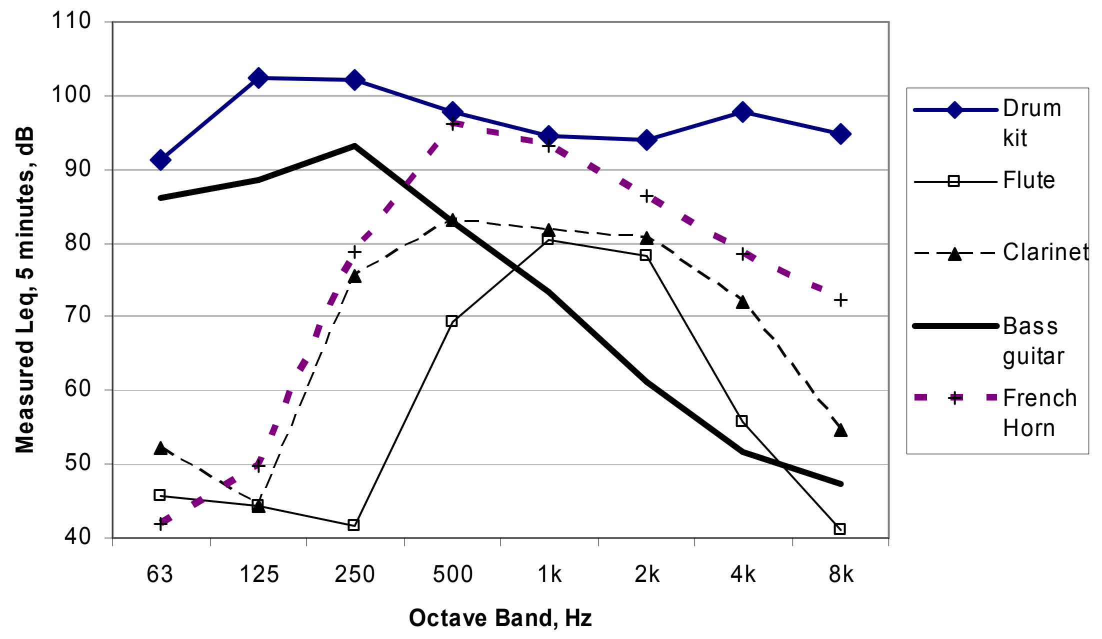


Figure 2 shows measured sound pressure levels for various types of musical instrument, measured in terms of Leq over 5 minute periods. They are not claimed to be definitive levels as they were measured in different rooms and with different standards of players. None the less this illustrates the substantial difference between sound insulation requirements needed for, say, woodwind and brass practice rooms, and also shows the substantial increase in low-frequency insulation needed to cope with bass guitars and, of course, drums.

Our experience is that the minimum standards in BB93 are appropriate for singers and most types of stringed and woodwind instruments. They are not really adequate for pianos (except when used purely for accompanying other instruments, when they tend to be played fairly quietly), brass and most types of percussion, and as discussed above are not applicable to rock and pop music. It therefore makes sense to allocate different types of rooms for different instruments if possible.

3. ROOM ACOUSTICS FOR MUSIC PRACTICE ROOMS

BB93 specifies room acoustics solely in terms of reverberation times. In general we have found that, in small practice rooms in particular, RTs significantly shorter than the 0.8 seconds permitted under BB93 are desirable.

The guidance in BB93 recommends the practice of angling practice room walls to avoid flutter echoes and strong room modes. We have measured some very impressive flutter echoes and room modes in small practice rooms with one pair of walls as much as 10 degrees out of parallel. In other rooms with parallel walls the expected flutter echoes have not arisen. Given the additional complexity of building non-parallel walls, there is a good case for not doing this and instead relying on absorbent and diffusing finishes on the upper parts of the walls to control these effects. Flutter echoes between floor and ceiling are very rare in small rooms so we generally advise carpeted floors, plasterboard ceilings and absorbent / diffusing wall finishes.

We have found that bass guitars are much more efficient at exciting flutter echoes, modes and rattles than natural instruments. For these rooms it is desirable to reduce the RT yet further, introduce large amounts of diffusion on walls and ensure that light fittings, cable trunking and air diffusers are very firmly fixed, using damping materials if necessary to reduce rattles.

4. STUDIOS

There are several different types of studios and for a client to say “ We want a recording studio” is like saying “ We want a hall” or indeed “We want a car”. The consultant’s first job should be to get a more specific brief. This is not easy if the client has little idea of what types of studio are available, and few architects have experience of this type of facility.

There is some guidance published by the DfES on this subject – notably Building Bulletin 86 [4], Building Bulletin 98 [5] and the first draft of Building Bulletin 99 [6]. Building Bulletin 86 is already rather dated and is in some areas contradicted or superseded by the guidance chapters in BB93. For example, it suggests one layout in which a recording control room is linked to its live room by a single door. This is bad practice both acoustically and operationally, but seems to be reflected in the initial layouts produced by many architects. The guidance in Chapter 5 of BB93 is not much more helpful in that it states that “A recording studio as such rarely exists in a school”. This was drafted in 2002 and is already seriously out of date, which merely shows how quickly school building projects are changing with the introduction of specialist school status in the performing arts.

BB98 and its draft counterpart BB99 set out briefing frameworks for primary and secondary school projects respectively, and include suggestions for floor areas for different types of rooms, including music accommodation. This is supplemented by the online DfES document "Assessing the Net Capacity of Schools" [7]. While this is useful guidance for most areas of schools, the author has found that in many cases clients and architects take the area requirements in these documents as gospel and that in particular they result in fixed area allocations for recording studios and control rooms which are simply too small for modern music departments.

When we become involved in this type of project, therefore, it is generally at the stage at which preliminary layouts and room sizes have been agreed and we have to go through the painful process of revisiting these for studios. Common faults are control rooms which are too small for teaching, live rooms which are too small for bands, failure to provide separate control rooms and, of course, layouts which simply do not work for sound insulation – notably the habit of linking studios and control rooms by doors rather than accessing them from a separate lobby area.

The following summary of studio types is not definitive but may be of help.

Live room for recording bands
The minimum size for a live room to record a normal rock band (two guitars, bass guitar, drums and vocals) is 5 x 4 m and even so there may be significant "bleed" between the microphones. 6 x 5 m is better and allows for the provision of a drum booth or moveable screens. Room height is not critical as the ceiling has to be acoustically very absorbent. Very short RTs are required – typically less than 0.4 seconds. A vocal booth may be included within the live room – if this is large enough it can be used it as a drum booth (this is rare) or it can accommodate one or two instrumentalists to give some separation, with the drum kit in the main studio. It may also, of course, be used for vocals. In practice, most band recordings have vocals dubbed later, but the vocalist does also record a "guide track" with the band to give the instrumentalists an idea of what they are supposed to be playing to.

Live room for recording classical music
For classical music a studio has to be much larger for two reasons :

a) "Close-miking" is not appropriate for most classical instruments. Microphones are located at some distance to obtain blend between instruments, although additional close microphones may also be used for later adjustment of the balance.

b) A longer RT (hence larger volume) and more "spacious" acoustic are required.

Ideally we would use a classroom-sized space (>40 m^2) for a small group and a recital room (>80 m^2) for a larger group or for any recording using a piano. Ceiling heights should be not less than 3 m for smaller rooms, 4 m for larger ones.

Voice-over booth
This is a separate small, very dead recording studio for recording speech only. Typical uses are for recording announcements, commentaries, audio books, etc. These are very rarely required in schools and if needed the vocals booth in a band live room is generally appropriate.

Control rooms
Most control rooms are too small, especially in schools where space is required to teach a small group of people how to use a sound desk. 3 x 4 m should be a minimum, 5 x 4 mis comfortable for teaching 4–6 pupils at a time. A reasonable digital sound desk (which is all that most schools need or can afford) is no more than 1m x 1m, but we have to allow space behind for plugs and cabling. Other necessary equipment will include a computer, but in general for most schools all of the essential control equipment would fit onto a 2 x 1 m desk. In principle, the control room could be designed so that the desk could be under either of two observation windows in the layout shown in Figure 3. Monitor loudspeakers are required at reasonable separations (2 for stereo or 5 for surround monitoring). There should be at least two swivel chairs on castors, plus seats for students or other observers.

A much larger sound desk may be needed where the syllabus includes teaching recording engineering but schools and colleges offering such courses would be expected to have several studios and control rooms of different types.

To save on space and equipment in a school, the same control room may be used for several live rooms and Figure 3 shows a possible schematic layout which allows one control room to serve a live room for bands, a classroom which can also be a recital room and classical studio, and a separate vocal booth.

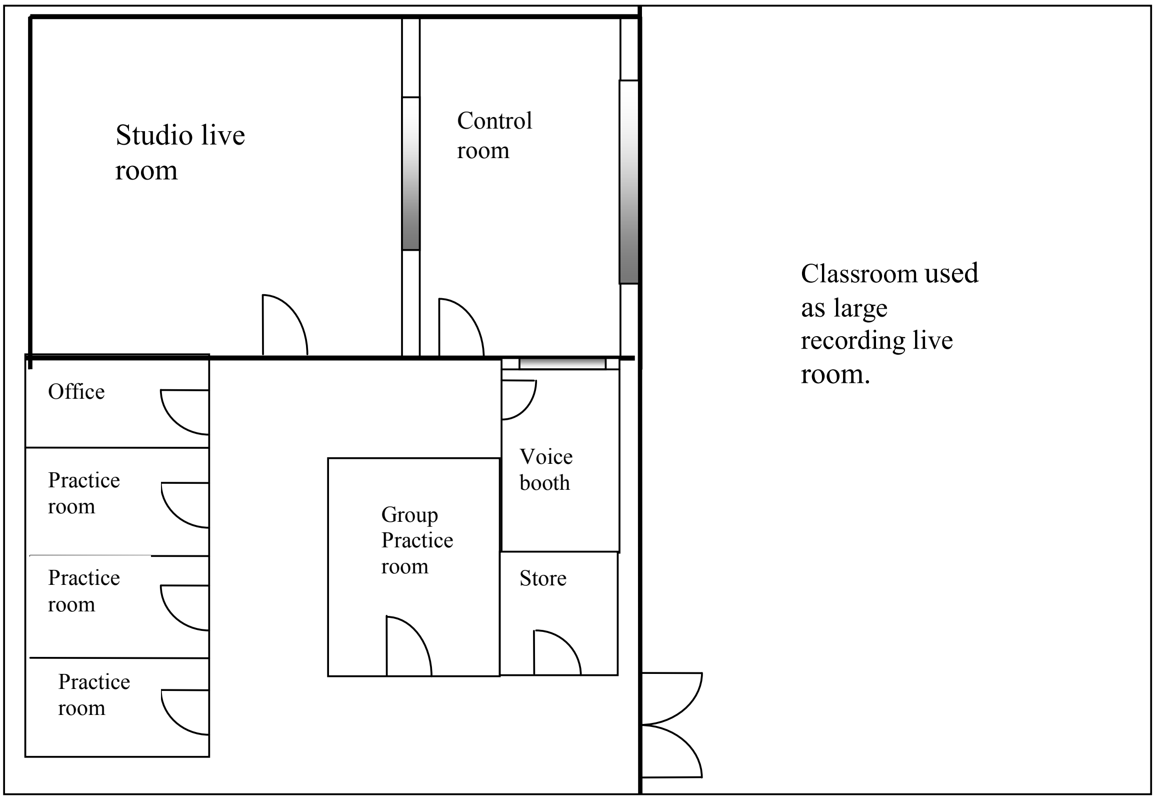


Figure 3 – A possible schematic layout of a school's recording suite

Services

All of these rooms will need low-noise mechanical ventilation and cooling. Natural ventilation tends to be a problem because of the sound insulation required. Quite large air volumes and cooling capacities are needed because the recording equipment can generate a significant amount of heat, but the location of plant is often neglected. Fan coil units in studios and control rooms are not generally viable as they generate too much noise and separate ducted systems should be designed in from the start.

5. HALLS AND THEATRES

Enough has already been written about the acoustic design of halls in schools for theatrical and other uses. The operational aspects, however, tend to be neglected and these are really not covered in any of the guidance. A few common problems are :

- Inadequate stage size and backstage facilities - the point of school drama is often to involve as many pupils as possible in theatrical productions, yet it is still assumed that the small stage typical of the 1970's assembly hall should be adequate. These often have a fixed proscenium and curtain, and sometimes provide access from only one side of the stage. In most cases it is not difficult to provide a layout in which classrooms and art studios can be used as dressing rooms and scenery stores accessible from backstage, with a crossover behind the stage. Many theatres work well without a flytower but very few work without adequate space behind and alongside the stage
- Fixed stage heights and non-raked seating - a drama stage with flat floor seating has to be higher than that with raked seating to provide adequate sightlines. At such a height a stage will be unsuitable as a concert platform. There is a welcome trend towards the use of adjustable-height, moveable rostra, adjustable proscenium panels and raked seating, often on retractable bleachers to provide flexibility. At this point the appointment of an experienced specialist theatre consultant becomes essential.
- Sound, lighting and rigging systems – relying on a single supplier to specify and supply the equipment may not be the best form of procurement, as some suppliers will tend to deal with a limited range of equipment which may not be the best for the project in hand. The theatre consultant and acoustics consultant will normally draw up a list of equipment and a technical specification. The savings from competitive tendering for this equipment will often more than justify the extra consultancy fees.
- Lighting positions – school halls are still being designed and refurbished on the assumption that lights can be hung from a pair of scaffold tubes fixed to the ceiling over the audience. Installing, adjusting and maintaining these lights is a serious safety issue as well as being inconvenient. If lighting bridges can not be installed within the budget (and frequently they can not) a means of lowering the lighting bars on cables should be considered.
- Control positions – Ideally a dedicated sound and lighting control room should be included. The parameters are similar to those for studio control rooms. If this is not feasible in a hall refurbishment, a location for a sound and lighting desk within the auditorium should be identified and provision should be made for cabling to a wall or floor box at this location.
- Ventilation – Any space in which an audience of several hundred people will sit for, perhaps, several hours has the capacity for becoming very hot and uncomfortable. Building Bulletin 87 provides very clear guidance on the ventilation requirements, and fresh air supply is if anything more important than temperature control. Unfortunately, this guidance can be ignored in refurbishments where complying with BB87 and with Part F of the Building Regulations is not considered essential. This is a good example of designing to meet the Regulations rather than the realistic needs of a project. The result can be very uncomfortable indeed.

6. CONCLUSIONS

The introduction of Building Regulations for schools has had a welcome impact on the quality of the teaching environment. During the consultation period, some of those consulted predicted that some projects would be designed merely to comply with the minimum requirements in BB93 rather than to the real needs of the project, and in many cases they have been proved correct. The fault lies not, however, with the concept of the Regulations or the Building Bulletins but rather with the philosophy of briefing for school projects. It is very easy for a client or project manager to draw up a brief by reference to standard DfES guidance without having to think too deeply about whether the numbers really meet the needs of the school. Designing to a formula is no substitute for a proper, multi-disciplinary approach to a well thought-out brief, particularly for performance areas.

The acoustics consultant is often the only person on the design team with any experience of performance areas. We have both the opportunity and the duty to our clients to ensure that the brief for these areas is appropriate, not just acoustically but also operationally. If we do not have the necessary expertise in technical design of studios and theatres, we should encourage the appointment of separate specialist theatre consultants or studio designers.

Merely complying with the minimum requirements in Section 1 of BB93 may not be adequate for some projects. There is a great deal of useful guidance in the later chapters of BB93 which is often ignored because it is not mandatory. We should use this and encourage our project architects to do the same. At the same there is a need for more detailed guidance on the acoustic and non-acoustic aspects of performance areas in schools.

7. REFERENCES

1. Department for Education and Skills, Building Bulletin 93 “Acoustic Design of Schools”. http://www.teachernet.gov.uk/acoustics

2. A James, A Thompson “School acoustics after BB93 - practical problems and solutions” Proc IoA, Vol 25, Part 4 (2003)

3. J Miller “Design Standards for the sound insulation of practice rooms”. Acoustics Bulletin 18(6). (1993)

4. Department for Education and Employment, Building Bulletin 86 “Music Accommodation in Secondary Schools”. 1997. The Stationery Office, ISBN 0-11-271002-6

5. Department for Education and Skills, Building Bulletin 98 “Briefing Framework for Secondary School Projects”. 2004 http://www.teachernet.gov.uk/acoustics *(This supersedes Building Bulletin 82 : 1996 “Area Guidelines for Schools”)*

6. Department for Education and Skills, Draft Building Bulletin 99 “Briefing Framework for Primary School Projects”. 2005 http://www.teachernet.gov.uk/acoustics (*This also supersedes Building Bulletin 82 : 1996 “Area Guidelines for Schools)*

7. DfES, “Assessing the Net Capacity of Schools” http://www.dfes.gov.uk/netcapacity/

8. Department for Education and Skills, Building Bulletin 87 “Guidelines for Environmental Design in Schools”. Revised 2003. http://www.teachernet.gov.uk/management