Introduction

The problems with NOISE

Background noise refers to any undesired auditory stimuli that interferes with what a child wants, or needs to hear and understand (Crandell et al. 1995)

Excessive noise is a much more serious and widespread problem than poor room acoustics.

It may not be obvious to the teacher that the students are having increased difficulty, because adults can understand speech in noise better than younger children.

Flexer, in an article for Hearing Journal (August 2002) stated, "People can fill in the blanks of missed information only if they have that information already stored in their brain's "data bank" from where they can retrieve it. Because they do not have those data banks, children need a sharper auditory signal than adults do. Thus, while a classroom might sound fine to an adult, it may be woefully inadequate for typical children who are neurologically undeveloped and have not had decades of language and life experience.

All this means that children require a quieter environment and a louder signal than adults do in order to learn."

For adults to make sense of a speaker in noise they need to have the speaker's voice (Signal) 6 dB louder than the background noise (Noise). This is a Signal to Noise (S/N) ratio of + 6dB.

Whereas a child needs + 16 db S/N ratio and a hearing impaired child needs a +20 to +30 dB S/N ratio.

A typical classroom is likely to be between +5 and -7 dB.

Flexer defines the S/N ratio as "the relationship between the primary or desired auditory signal to all the other unwanted background sounds." She also states, "The more favourable the S/N ratio, the more intelligible the spoken message." and "S/N ratio is the key to hearing intelligible speech."

Bradley and Sato (2004) used the Word Intelligibility by Picture Identification (WIPI) speech discrimination test to find the optimum S/N ratio for 6, 8 and 11 year olds to achieve a 95% correct score. They evaluated a total of 878 students in 43 classrooms. Their findings were:-

Age	S/N Ratio
Grade 1 – 6 yrs old	+ 15.5 dB
Grade 3 – 8 yrs old	+12.5 dB
Grade 6 – 11 yrs old	+ 8.5 dB

Year Group																
	Nursery		Reception		Year 1		Year 2		Year 3		Year 4		Year 5		Year 6	
	LAeq	LA90	LAeq	LA90	LAeq	LA90	LAeq	LA90	LAeq	LA90	LAeq	LA90	LAeq	LA90	LAeq	LA90
Islington Average			74.7	62.9	74.0	59.6	66.9	51.8	68.5	52.9	67.4	48.1	69.8	54.4	66.5	51.2
Haringey Average	71.9	57.3	73.3	61.9	74.7	62.8	65.0	50.4	69.5	51.9	71.3	51.8	75.6	52.9	74.3	55.7
Overall Average	71.9	57.3	73.9	62.3	74.3	61.0	66.3	51.3	68.9	52.5	69.6	49.8	73.2	53.8	71.2	52.9

Shields and Dockrell in their study, where they measured the internal noise of 16 classrooms, showed that the level of noise was mainly due to the students themselves and that there was a general trend for the noise to decrease as the age of the children increases. There was anecdotal evidence from the teachers that this is the case and that nursery and reception classes can be particularly noisy. The table below is from their study.

LAeq refers to the "equivalent" average sound level measured using the A-weighting which is most sensitive to speech intelligibility frequencies of the human ear.

LA90 refers to the A-weighted sound pressure level which is exceeded for 90% of a specified time period T - this parameter is often taken to represent the background noise level.

The younger a child the greater the S/N ratio needed for them to understand the speaker.

Flexer also refers to the fact that we hear with the brain and the ears are only a means of getting the sound to the brain. She also states that children cannot listen like adults as their higher auditory brain centres are not fully developed until the age of 15. Children cannot perform auditory cognitive closure like adults. (Auditory cognitive closure is the ability of the listener to 'fill in the gaps' of the conversation they are listening to.)

If results from these researchers are combined then a nursery aged child could expect to be in levels of noise of 72.9 dB(A) and they would need a S/N ratio of + 15.5 dB if they were to hear and comprehend 95% of what the teacher is saying. This means that the teacher needs to use a voice level of 88.4 dB(A) for the child to benefit educationally. This is an impossible level for the teacher to maintain for any period of time.

This makes it imperative that noise levels are reduced to acceptable levels.

Noise and attainment

There have been many studies which used reading scores to look at the effect of noise on the attainment of students. These studies have mainly looked at reading scores. Bronzaft and McCarthy (1975) found that children on the quieter side of a school, next to an elevated railway, had reading scores higher than children on the side exposed to the train noise, at levels up to 89 dB(A). The train noise was later reduced inside the school by 6 to 8 dB(A) after which no difference between scores was found.

Other studies looked at the effects of aircraft noise and they came up with several different conclusions ranging from changes in teacher's behaviour to problems with poor long term memory and reading comprehension. (Cohen et al. 1980, 1981)

Other studies looked at problems associated with traffic noise. Lukas et al. (1981) found that exposure to traffic noise had a detrimental effect on reading.

A study by Earthman and Lemasters (1998) reported three key findings:

1. Higher student achievement is associated with schools that have less external noise
2. Outside noise causes increased student dissatisfaction
3. Excessive noise causes stress in students

Shield and Dockrell's study came up with seven main conclusions:

1. Noise inside classrooms is not generally affected by external noise; the main source of noise is the children themselves
2. Noise inside and outside schools has an effect upon children's performance in standard assessment tests, the background noise in classrooms having the greater effect
3. The SATs results of older (Key Stage 2) children are more affected by noise than those of the younger children
4. Children in primary schools are aware of environmental noise and annoyed by the noise from other sources
5. Noise and classroom conditions affect children's ability to hear the teacher
6. Classroom babble has a detrimental effect upon language based tasks
7. Children with special educational needs are more affected by classroom noise than other children.

As stated in the introduction noise needs to be kept to a minimum if the listener is to have any chance of understanding what is being said by a speaker especially for the Primary aged students.

Survey data collection

Equipment required:

Sections 1 and 2 - pen and paper:
Sections 3 and 4 - sound level meter (SLM) (type 1)

1. Draw a plan/map of the school/classroom.

Always draw a map or plan of where the testing will take place. When you write the report, the map or plan can be used to help describe the problem.

Maps

Aerial maps, which can be used to show the school and the surrounding environment, can be found on the internet. If you put the map in a Word document, you can highlight any noise problems like factories, railways, roads etc.

Route planners on the internet can also be used to show the geographical position of the school. Unfortunately they won't always show factories etc. and you may have to draw them on yourself.

Show on the map which direction South is. This is important as in the summer, when it is hot the windows may be opened letting in all the external noise.

Always show on the map the position of the classroom you are surveying.

Larger maps may be used to mark on any areas where outside activities may be taught on a regular basis. These are potential noise sources which may only be used in summer and not be in use when you do the survey. If they are outside the classroom and the classroom is south facing then this is a source of noise not in control by the teacher in the classroom.

Plans

Most schools will have plans showing the layout of the rooms. It is very useful to look at this plan as it will show the proximity of the classroom to the boiler room, assembly hall, gymnasium or sports hall and other classrooms.

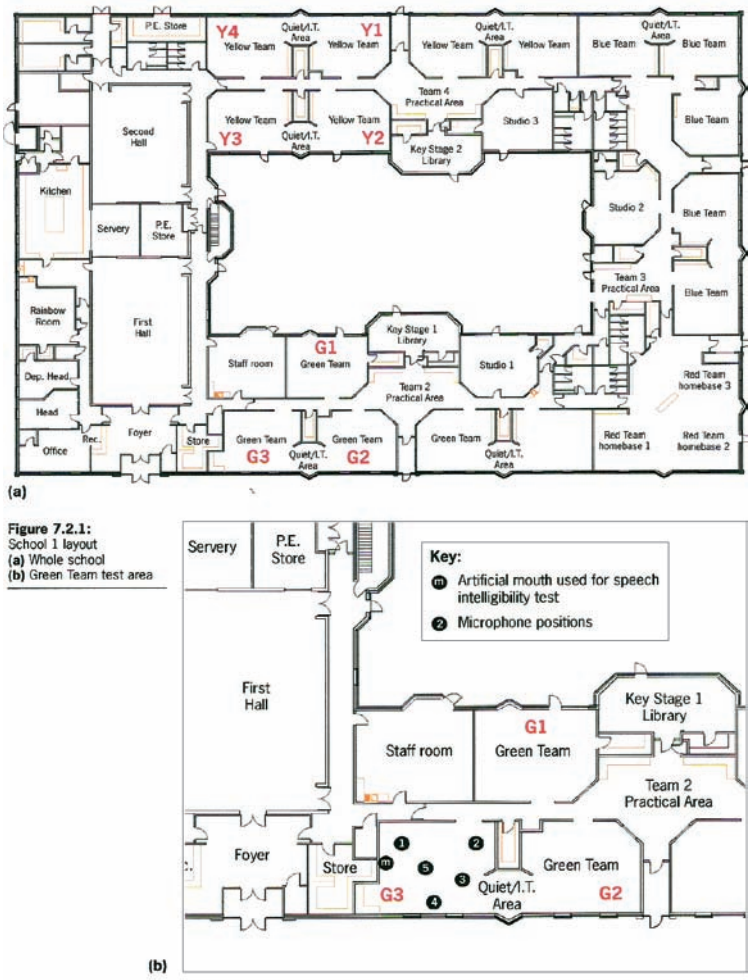


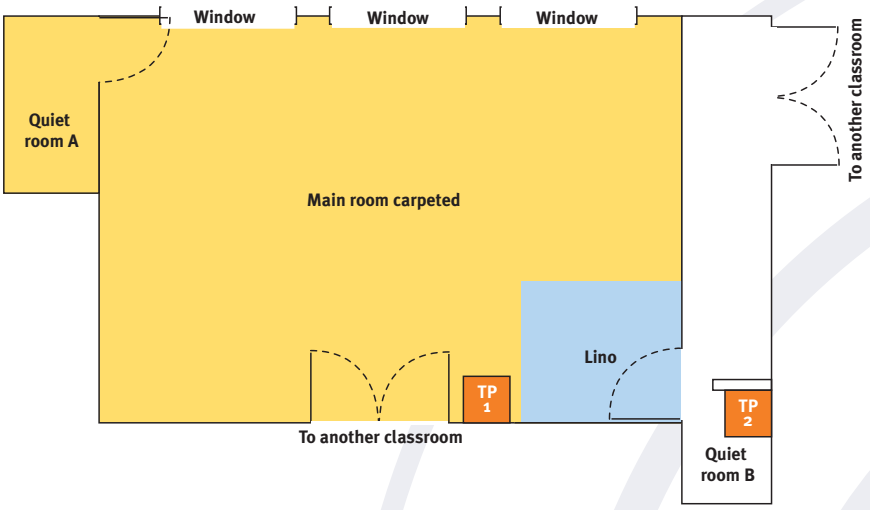
Figure 7.2.1:
School 1 layout
(a) Whole school
(b) Green Team test area

The plan opposite is taken from BB93. It is used as part of a case study looking at the acoustics in open plan classrooms.

The plan shows the whole school and then a closer look at the classroom and the surrounding rooms.

The enlarged view also shows the test positions for a 'Speech Transmission Index' test.

If a plan is unavailable, you should draw one yourself. It doesn't need to be a scale drawing but it needs to show all noise sources.



Photographs of the test rooms could also be useful in reports.

2. **Record the weather conditions, especially the wind direction. This is important as the prevailing winds are west and, southwest and on the day of the test the wind may be in a different direction causing results which may not be normal for the school.**
3. **Use the SLM and the survey data collection sheet.**

How to do the survey

You will know from the preliminary survey and the pupil interview the particular area needing further investigation. The same principles apply to all the surveys, draw a plan, record weather conditions (if outside), note all the noise sources and record the noise levels using a SLM.

You need to know the type of SLM you are using. It is a good idea to sit with all types of SLM's and record the noise sources.

For a type 3 SLM, sit with the SLM pointing to the noise source and record an average dB(A) reading every 30 seconds.

For a type 2 SLM, set the SLM to FAST and use the dB(A) weighting. Record an average dB(A) reading every 30 seconds.

For a type 1 SLM, set the SLM to record a LAeq,10min and leave for 10 minutes.

4. **Written report and recommendations.**

resource remove and photocopy

Survey data collection sheet

Category

Date of Test ..... Time Period .....

Plan/Map

(Mark on as many details as possible, especially your test position The plans in the Reverberation Time Section could be used to obtain detailed information about materials in the classroom.)

Position (as per plan)

Weather Conditions

Sound Level Meter Used

Data

Date	Time	Average dB(A)	Comments

Average Noise Level ..... dB(A)

General Comments and Observations

Noise Surveys for specialists

Worked example 1

Noise outside the school

Case study

A severely deaf child is in nursery and starting in reception in September. The child's teacher of deaf children is looking at the school and the room that this child is going into.

The room is near a major dual carriageway which is a ring road for a major city carrying heavy traffic at all times. Also nearby is a local tram system.

A plan of the school and surrounding area was drawn highlighting where the proposed classrooms will be sited.

Measurements were taken on two consecutive days.

The weather conditions were the same on both days, dry with a moderate breeze. The temperature was warm.

As the student was very young, no pupil interview was performed. The times chosen for the survey were based on the Preliminary Survey and knowledge of how the teacher structures her lessons. It was decided to perform the survey at three different times: the beginning of the morning lesson when the traffic was still heavy and the teacher was giving instruction to the class; at the end of the lesson; and at the end of the day.

Test equipment used:
Sound level meter used – Eagle Y139A – Type 3 SLM

Time periods assessed were – 9.05 to 9.15, 11.55 to 12.05, and 3.10 to 3.20
These times were chosen as they are the times of the day when pupils may be given important instructions by the teachers.

Results

Day 1 (date of survey.....)

Position (A) - Outside the current reception classroom where it is proposed a hearing impaired pupil is to be taught from September next year.

Weather conditions – The weather was dry with a moderate NW breeze

Time Periods	Average Noise Level dB(A)
9.05 to 9.15	76
11.55.to 12.05	68
3.10 to 3.20	73

Comments – The traffic was particularly heavy during the first period as it was still rush hour. Also a nearby tram line has a particularly noisy junction close by where the tram makes a squealing noise as it crosses to tracks. It would appear to me that it is a mainly high frequency sound.

Day 2 (date of survey.....)

Position (B) - This is a proposed alternative classroom.

Weather conditions - The weather was similar to yesterday with the wind maybe slightly stronger.

Time Periods	Average Noise Level dB(A)
8.45 to 9.00	68
11.55.to 12.05	57
3.10 to 3.20	61

Comments – It was perceptively quieter in this position and the results above reflect this. The tram was noticeably quieter, as was the traffic, even though it was just as busy.

The table below compares the noise levels at the two different positions.

	Position A	Position B
Time Periods	Average Noise Level dB(A)	Average Noise Level dB(A)
8.45 to 9.00	76	68
11.55.to 12.05	68	57
3.10 to 3.20	73	61

Recommendations

As position B is noticeably quieter at peak times it would mean that the ambient noise levels in the classroom at B would also be lower. This would make classroom B more suitable for teaching a deaf student wearing hearing aids.

There is little that can be done to lower outside noise levels other than building barriers or moving the traffic.

The case study shows that choosing an alternative classroom as far away from the noise source as possible is one answer to the problem.

It is important to walk round the sight and listen to any noise sources and list them.

The Shields and Dockrell study took 5 minute noise samples outside 142 schools in 3 boroughs in London. The list below is percentage scores of the incidence of the most commonly occurring noise sources in the three boroughs.

Car	86%
Passerby	70%
Children's voices	56%
Aeroplane	54%
Adult voices	41%
Lorry	35%
Trees	25%
Bus	24%
Door/Gate banging	20%
Birds	20%
Construction Noise	18%
Motorbike	18%
Wind	16%
Train	11%

This is not a scale of the loudest but the most common. The list may contain some noises you may not be looking for and some may be insignificant e.g. birds.

One other source of noise not mentioned yet is from lessons taking place outside, either in a playground or on a playing field. The reason for marking South on the plan is that in the summer, when it is hot, the windows may be opened and any noise from lessons outside will enter the classroom. The suggestion of a suitable classroom should take this into account.

Regulations - BB93 does not apply to external noise, the following recommendations are considered good practice for providing good acoustic conditions outside school buildings.

For new schools, 60 dB LAeq,30min should be regarded as an upper limit for external noise at the boundary of external premises used for formal and informal outdoor teaching, and recreational areas.

Under some circumstances it is possible to meet the specified indoor ambient noise levels on site where external noise levels are as high as 70 dB LAeq,30min but this will require considerable building envelope sound insulation, screening or barriers.

Noise levels in unoccupied playgrounds, playing fields and other outdoor areas should not exceed 55 dB LAeq,30min and there should be at least one area suitable for outdoor teaching activities where noise levels are below 50 dB LAeq,30min

(from BB93, pg 21).

Noise Surveys for specialists

Worked example 2

Noise inside the classroom

school empty

Background information

This is the only one of the four surveys that has regulations for new school builds and new extensions. (This does not apply to refurbishments).

The following is taken from BB93

Indoor ambient noise levels in occupied 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 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)
- building services (eg ventilation system etc). If a room is 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 operating duty.

The indoor ambient noise level excludes noise contributions from:

- teaching activities within the school premises, including noise from staff, students and equipment within the building or in the playground. Noise transmitted from adjacent spaces is addressed by the airborne and impact sound insulation requirements.
- equipment used in the space (eg machine tools, CNC machines, dust and fume extract equipment, compressors, computers, overhead projectors, fume cupboards). However, these noise sources should be considered in the design process.
- rain noise. It is intended that a standard for rain noise will be introduced in a future edition of BB93.

In summary, when measuring for 'indoor ambient noise levels in occupied spaces':

1. windows should be open as if it is a hot day, any ventilation system should be turned on at its operating duty
2. the heating system should be on
3. all machines normally used in the room should be switched off
4. no other activity should be taking place within the school
5. it must not be raining

The noise needs to be measured as an LAeq,30min, which is an average noise level for 30 minutes.

The indoor ambient noise levels in the following table apply to finished but unoccupied and unfurnished spaces.

Type of Room	Upper limit for the indoor ambient noise level LAeq, 30min
Nursery school playrooms	35
Nursery school quiet rooms	35
Primary school: classrooms, class bases, general teaching areas, small group rooms	35
Secondary school: classrooms, general teaching areas, seminar rooms, tutorial rooms, language laboratories	35
Open Plan	
Teaching areas	40
Resource areas	40
Music	
Music classroom	35
Small practice/group room	35
Ensemble room	30
Performance/recital room	30
Recording studio	30
Control room for recording	35
Lecture rooms	
Small (fewer than 50 people)	35
Large (more than 50 people)	30

Classrooms designed specifically for use by hearing impaired students (including speech therapy rooms)	30
Study room (individual study, withdrawal, remedial work, teacher preparation)	35
Libraries	
Quiet study areas	35
Resource areas	40
Science laboratories	40
Drama studios	30
Design and Technology	
Resistant materials, CADCAM areas	40
Electronics/control; textiles, food, graphics, design/resource rooms	40
Art rooms	40
Assembly halls, multi purpose halls (drama, PE, audio /visual presentations, assembly, occasional music)	35
Audio-visual, video conference rooms	35
Atria, circulation spaces used by the students	45
Indoor sports hall	40
Dance studio	40
Gymnasium	40
Swimming pool	50
Interviewing/counselling rooms, medical rooms	35
Dining rooms	45
Ancillary spaces	
Kitchens	50
Offices, staff rooms	40
Corridors, stairwells, coats rooms and changing	45
Toilets	50

As stated earlier, the indoor ambient noise levels in the table are for new builds and new extensions. If the school you wish to survey was built before July 2003 then the noise levels don't apply as regulations. However, it is good practice to keep indoor ambient noise levels to a minimum as these are noises out of the control of the class teacher.

The best SLM for this survey is a type 1 as it will be able to produce an LAeq,30min. As well as the LAeq,30min you will also need to record the sources of the noise, especially the loudest.

Using either of the other two types of SLM will not produce a LAeq,30min but they will provide you with useful information about the noises entering the classroom from other sources.

Case Study

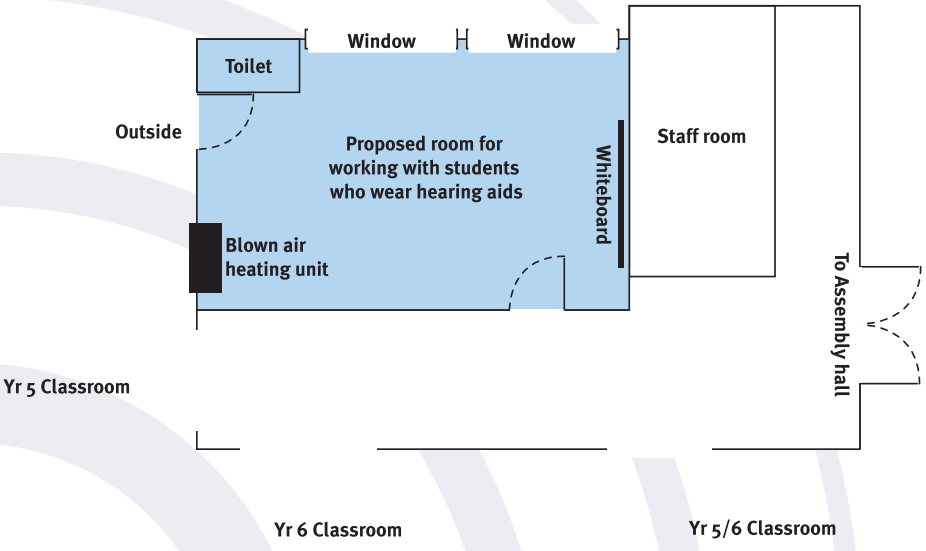
A mainstream school has been requested to develop a resource for Primary aged deaf students. The students will be taught using an oral/aural approach and they will all have a statement of educational needs. They have been allocated one room within the school. It is envisaged that the maximum number of students using the room will be 10 with ages ranging from nursery to Y6. It is also proposed that the students will be integrated in the mainstream classes as much as possible and the room will be used mainly for small groups and individual work.

This report has been requested as part of an assessment of the suitability of a room for use with deaf students.

The school

The school is a small single storey building built in 1978, situated on the edge of a quiet housing estate. Two sides of the school grounds face onto open fields used for grazing and the other two sides are facing houses. The nearest road is 100 m from the front of the school and there is little traffic using it. The road isn't a bus route and there is no railway line or heavy industry nearby.

The Room



The room being allocated for the resource is at the front of the school. It is self contained, with its own access door to the outside. Included with the room are some toilets for the use of the students.

The room is north facing and there are no other classrooms attached to this room. The only room attached is the staffroom.

The room is ventilated using windows and the heating system is individual blown air heaters. There is one in this room.

Test equipment used:

Norsonic Type 1 sound level meter - serial number 28930

Norsonic calibrator type 1251

Indoor ambient noise level (IANL)

The testing took place when the school was empty. The windows were open and the heating switched on. The testing took place between 9.10 and 9.40 when the teacher would be working with the students.

The SLM was set to measure an LAeq,30min and records were made of the noise sources.

The result of the test was an LAeq,30min of 46.8 dB(A).

This noise level was produced entirely by the heating unit. There was no evidence during the testing of traffic noise or any other noise from outside the room.

Comments

The current regulations for measuring indoor ambient noise levels are from BB93 and for a room specifically designed for use with hearing impaired students the IANL should be 30 dB(A). However, BB93 applies to schools built since July 2003 and this school was built in 1978. It is not required for this room to comply to BB93 but the recorded noise level would be unacceptable for working with hearing aided students. The room in the case study is an ideal room for a hearing impaired resource in that it is isolated from classrooms and there is no problem with external noise causing any problems. The only real problem is the heating system.

The youngest of the students working in the room require a Signal to Noise ratio of +20 to +30 dB if they are to be able to hear and understand what the teacher is saying. This level of background noise would require the teacher to raise their voice and maintain that level for prolonged periods of time causing strain on the teacher and the student.

Recommendations

The heating unit should be serviced and possibly replaced in order to reduce the noise to acceptable levels.

Your preliminary survey will tell you if this is the main problem. In the case of this school, it was the main problem but there were other issues with it being partly open plan.

If, in your survey, you find that the noise is mainly from the boiler (plant) then you may need to look at a different room as far away from the noise as possible.

If the noise is due to the heating or ventilation system then they should be serviced and attempts made to reduce the levels of noise.

Also, if the main noise source is traffic, then look to try to move the classroom as far away from the traffic noise as possible.

Noise Surveys for specialists

Worked example 3

Noise inside the classroom

normal working conditions, no children in the classroom

Background information

There are no regulations for this survey relating to the levels of noise in an unoccupied room when activities are taking place in the rest of the school. But this survey will indicate how much noise enters the classroom from adjacent rooms (above, to the side) or corridors etc. This survey will indicate how good the walls, ceilings, windows etc, are at stopping sound from entering the room.

The regulations from BB93 (pg. 10) for this situation are to do with sound insulation between rooms. Measuring the performance of airborne sound insulation is outside the brief of this survey and document as a whole. If you feel this is a major issue then you need to hire an acoustic consultant/engineer to undertake the required tests.

The preliminary survey will indicate the main source of noise entering the room. You could now use the SLM to record noise levels in the room when it is unoccupied.

If you are using types 2 or 3 SLM's then use the 'Survey data collection sheet'. If you have a type 1 SLM then it can be set to record for any time LAeq you wish. A realistic time would be every two minutes. However, even with this type of SLM it is still advisable to use the data collection sheet to record what is happening in the class.

Case study

A profoundly deaf student is moving to a Junior school separate from the Infant school. The classrooms in the Infant school were all self contained but the Junior school is partly open plan ie. it has a separate classroom but doors have been removed between the rooms.

The preliminary survey found no problems with exterior noise and no excessive internal noise from an unoccupied building with all windows open and heating turned on.

The preliminary survey highlighted the main problem to come from other rooms when the students were working.

A noise survey was requested to measure noise levels in a room designated for use with a profoundly deaf student wearing a cochlear implant. Special attention was to be made of 'Quiet Room A' which was designated as a withdrawal area for one to one work between the deaf student and a teaching assistant.

The school

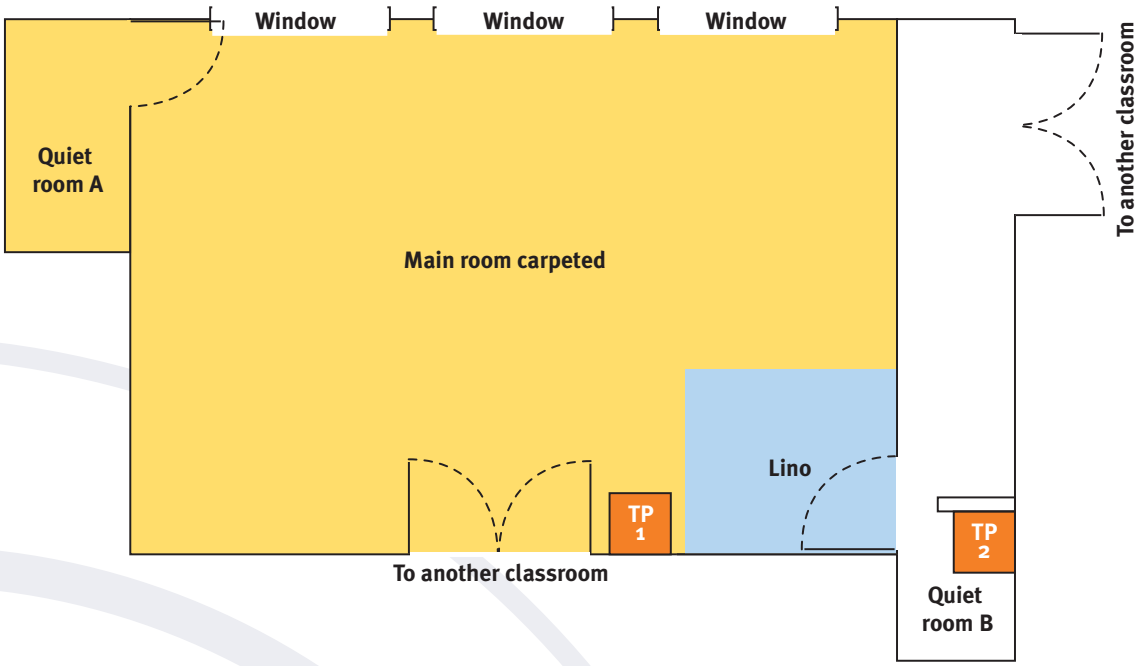
The school is a Junior school, built in 1965. It is a single storey, flat roofed building situated in a small housing estate in a small town. There are no problems with noise from outside.

The room

The room which the student will be taught in is at the corner of the school away from any influences from external noises.

The plan below shows the layout of the room, including the 2 'Quiet Rooms'. It was proposed that Quiet Room B be used for withdrawal of the hearing impaired student to enable one-to-one work with a teaching assistant.

Leading off the main classroom are accesses to other classrooms. Currently, Quiet Room A is used as a room for small group work with children from the main class.



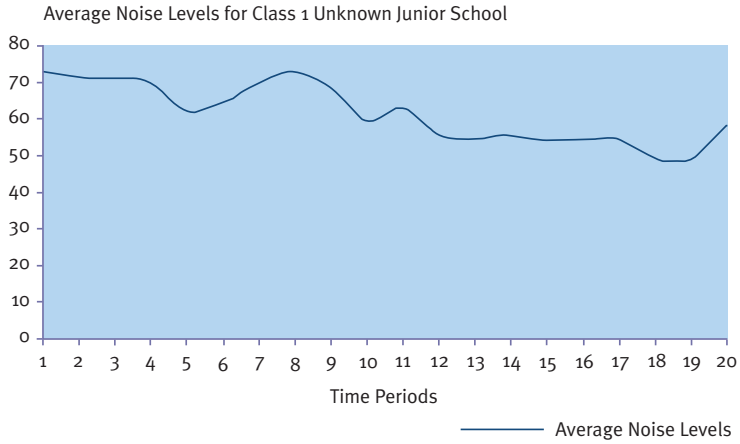
Test equipment used:

Norsonic Type 1 sound level meter - serial number 28930

Norsonic calibrator type 1251

Background noise measures

Testing took place in two positions, as shown on the plan. The class was to leave the room halfway through the testing period which provided an opportunity to measure noise levels with the class in and then when the room was empty.



The graph opposite shows the average levels of noise at 2 min intervals.

Up to time period 9 the class were in the room, after that the noise levels are from an adjacent classroom.

Also, at the end of time period 9, the SLM was moved to TP2. This means that the final noise levels are what the deaf child would experience when withdrawn, even if his or her own class was quiet.

Comments

The main problem with this room and speech intelligibility is the amount of noise able to enter the room from other classes.

In the first half of the test, the noise levels were fairly consistent at about 70 dB(A). This is when the class was getting ready to leave and leaving for the assembly hall.

The second half of the test again was fairly consistent at 55 dB(A) which was coming solely from children working in the next class .

Lowering noise levels in the classroom will allow the teacher to speak at a reasonable level and the pupils to hear easier.

Any pupils wearing hearing aids will have all sounds amplified and noise will 'mask out' the important parts of speech.

The provision and use of a 'radio aid' is vital in this situation as it will help the hearing aid wearer to hear the teacher's voice over the noise in the classroom but it will not stop the noise being too loud in the room.

Recommendations

Noise will always be an issue with speech intelligibility in this classroom and it is important that a quiet room with as little noise as possible is available for 1:1 work with deaf pupils.

'Quiet Room A' would be a more suitable room and also it would be easier to 'acoustically seal'. **There are three options for sealing the room:**

1. A permanent stud wall with sound treatment, double glazed windows and a door which would allow access to the room.

2. A sliding acoustic screen which could be folded back when not needed and closed when the noise entering the room is too great.
3. A heavy duty curtain with some acoustic properties which could be closed when needed.

There are advantages and disadvantages to all three choices.

Options 1 and 2 are the most costly but the most effective acoustically.

Option 1 will change the room into a separate room and spoil the effect of the open plan school.

Options 2 and 3 are the most flexible.

Option 3 will be cheapest but the least effective in terms of deadening the sound entering the room.

It would also be beneficial to put a barrier between the classrooms to reduce noise levels in the classroom.

Further information

This case study highlights the problems with well intentioned ideas of removing doors between classrooms to give the school a more open plan feel. However, this makes controlling the flow of noise very difficult. It relies on class teachers keeping their class quiet at all times. It also means that as a class teacher, you have no control over anybody else's class.

The report recommends using other Quiet Room A room for withdrawal and using some form of barrier to reduce the levels of noise entering.

This report includes a graph which helps to demonstrate the levels of noise measured over the test period. This is a useful tool and can be created quite simply using the results from data collection sheet and Excel. (Appendix A has instructions of how to create the graph).

This survey should highlight the weak spots in the room where noise is entering quite freely.

If the weak spot is a door then look at the tightness of fit and whether door seals need to be fitted. Could the door be upgraded to a door with better sound insulation properties?

There may be adjoining sliding doors between the 2 classrooms. If these doors aren't used, see if it would be possible for them to be removed and a partition wall built where the doors were.

In some old Victorian schools the classrooms are divided by sliding partitions which consist of mainly glass and wood. Could they be removed and replaced by a stud wall with good sound insulation?

The following table is from BB93 and shows the level of noise reduction required between rooms if they are to function with minimum disruption from noise entering the room.

(As in all cases, these regulation only apply to schools and extensions built from plans passed after July 2003 and no other school before then)

However, these figures are good guides for the levels of noise reduction between rooms.

You may be able to determine where the 'weak spots' are but qualified acousticians should be employed to determine the levels of noise reduction if that is what is required. They would be able to determine the present sound insulation and then calculate how much more is needed to comply to the regulation.

A type 1 SLM, with the necessary software, is needed for this level of testing.

Table 1

Type of Room	Room classification for the purpose of airborne sound insulation in table 2	
	Activity noise (Source room)	Noise tolerance (Receiving room)
Nursery school playrooms	High	Low
Nursery school quiet rooms	Low	Low
Primary school: classrooms, class bases, general teaching areas, small group rooms	Average	Low
Secondary school: classrooms, general teaching areas, seminar rooms, tutorial rooms, language laboratories	Average	Low
Open Plan Teaching areas Resource areas	 Average Average	 Medium Medium
Music Music classroom Small practice/group room Ensemble room Performance/recital room Recording studio Control room for recording	 Very High Very High Very High Very High Very High High	 Low Low Very low Very low Very low Low
Lecture rooms Small (fewer than 50 people) Large (more than 50 people)	 Average Average	 Low Very low
Classrooms designed specifically for use by hearing impaired students (including speech therapy rooms)	Low	Low
Study room (individual study, withdrawal, remedial work, teacher preparation)	Low	Low
Libraries Quiet study areas Resource areas	 Low Average	 Low Medium

Science laboratories		Average	Medium
Drama studios		High	Very Low
Design and Technology Resistant materials, CADCAM areas Electronics/control; textiles, food, graphics, design/resource rooms		High Average	High Medium
Art rooms		Average	Medium
Assembly halls, multi purpose halls (drama, PE, audio/visual presentations, assembly, occasional music)		High	Low
Audio-visual, video conference rooms		Average	Low
Atria, circulation spaces used by the students		Average	Medium
Indoor sports hall		High	Medium
Dance studio		High	Medium
Gymnasium		High	Medium
Swimming pool		High	High
Interviewing/counselling rooms, medical rooms		Low	Low
Dining rooms		High	High
Ancillary spaces	Kitchens Offices, staff rooms Corridors, stairwells, coats and changing rooms Toilets	High Average Average–High High Average	High Medium High High High

Table 2

Minimum DnT(tmf,max)w(dB)	**Activity noise in source room (see Table 1)**			
Noise tolerance In receiving room (see Table 1)	Low	Average	High	Very High
High	30	35	45	55
Medium	35	40	50	55
Low	40	45	55	55
Very Low	45	50	55	60

(Where D is the difference in sound levels between the source room and the receiving room)

The above table shows the amount of attenuation of noise required between rooms.

Example

If a unit for the hearing impaired (receiving room – noise tolerance 'Very low') is next to an assembly hall (source room – activity noise High) then there should sufficient sound insulation between the two rooms to attenuate the noise by 55 dB.

Achieving this level of attenuation will not make noise completely inaudible but it will make it less intrusive.

Noise Surveys for specialists

Worked example 4

Noise inside the classroom

normal working conditions, children in the classroom

Background information

There are no regulations in BB93 for this situation. However, knowledge of S/N ratios indicates that noise levels should be as low as possible to enable the teacher to teach without the need to raise voice levels.

Hearing Secondary aged students need a S/N ratio of +9 dB and a deaf student of nearer +20 dB if they are understand 95% of what the teacher is saying (see page 00).

The preliminary survey will indicate if there are any other problems with noise entering the room from outside.

If you are using types 2 or 3 SLMs then use the 'Survey data collection sheet'. If you have a type 1 SLM then it can be set to record for any time LAeq you wish. A realistic time would be every 2 minutes. However, even with this type of SLM it is still advisable to use the data collection sheet to record what is happening in the class.

Case study

A teacher of deaf children has used the 'Pupil Interview' with a Y7 severely deaf secondary pupil.

The student reported that the noise from the class in his French lesson made it difficult to hear the teacher despite using an FM system.

The teacher of deaf children decided to do a noise survey of this lesson and 2 other subjects. She would then report the results to the teachers in the hope that the noise could be reduced.

The school was newly built in September 2005. The reverberation times of the rooms were measured and found to comply with BB93. The preliminary survey showed no problems with noise entering the room from exterior sources.

All the classrooms tested were cuboid in shape and of similar size.

A noise survey was requested to measure noise levels in three rooms designated for use with a Y7 severely deaf student. The rooms tested are currently being used for teaching French, English and Mathematics.

The school

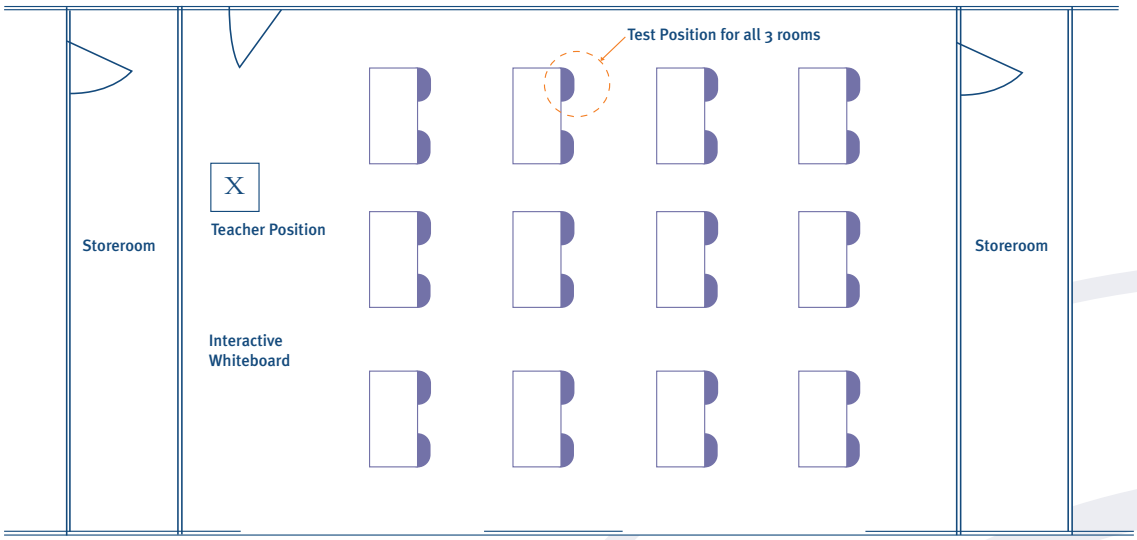
The school was newly built in September 2005. The reverberation times of the rooms were measured and found to comply with BB93.

The rooms

All the rooms are of similar size. They are all self contained with store rooms used as 'buffer zones between the rooms. All the rooms were zoned in subject areas and consequently were kept away from potential noisy subjects eg. Design and Technology, PE.

All the rooms are carpeted which reduces impact noise from rooms above. The roof of the school is metal but on the day of the test the weather was dry, so it is impossible to report rain noise as being a problem in the top storey rooms.

There was no evidence of traffic noise or noise from the plant.



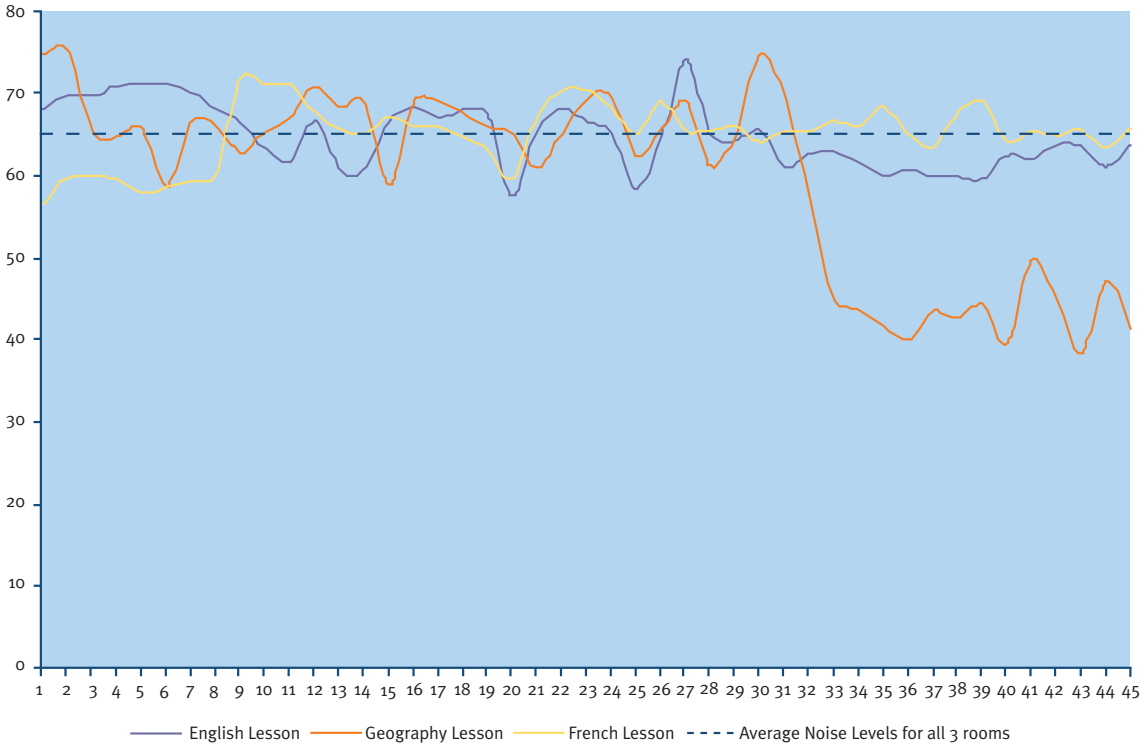
Test Equipment Used:
Norsonic Type 1 sound level meter - serial number 28930
Norsonic calibrator type 1251

Background noise measures

Testing took place in the position shown on the plan. This was a seating position normally occupied by the hearing impaired student as requested by the teacher of deaf children. The class teachers wore the FM system at all times during the lessons.

The graph below shows the noise levels at the beginning of all three lessons. The dotted black line is an average of all three lessons and is at 65 dB(A). The time period being measured were LAeq(1min). The total time period measured in each

room was 45 minutes starting at the beginning of the lesson when the teacher had started teaching.



Observations

The beginnings of all three lessons are similar for about 30 minutes which is the period when the teachers were giving instructions. The noise in the geography lesson dropped significantly when the students started working on individual tasks.

Conclusions

As the graph shows, the level of noise is often above the average line at levels of 70 dB(A) and above. This noise produced by the class was work related noise.

Pupils with normal hearing levels need to have the teacher's voice 10 dB louder than the noise if they are to be able to hear enough information from the teacher to make sense of the lesson. In this case the teacher would need to raise voice levels to 75 dB(A)+ if they were to be effective. If this voice level is maintained for a long period of time, the teacher could suffer voice problems which could prevent them from teaching.

A deaf student requires the teacher's voice to be 20 dB louder than the background noise which would mean the teacher speaking at levels of 85 dB(A)+. This is totally unacceptable.

Recommendations

Noise will always be an issue with speech intelligibility and it is important that internal noise is reduced to a minimum.

'Sound Field' systems have been shown to reduce levels of background noise and also help to reduce the strain on a teacher's voice. The system could be set up to become compatible with the hearing impaired student's FM system so that the class teacher would only be required to wear one microphone.

Internal noise is controlled by the teacher.

Unfortunately in a Secondary school the students move from room to room and in this case all rooms would need to have sound field systems. This means that the systems used would need to be infra red as there wouldn't be enough frequencies to use FM. Also, to completely fit a Secondary school with sound field systems would be expensive.

Looking at classroom management and teaching strategies is a difficult issue but may be the simplest and most cost effective way to reduce noise levels.

If the only source of noise in the room is from the students themselves then a training programme for the teachers, showing the problems the students have with noise may prove beneficial.

Inservice training can be used for all types of noise but especially with internal noise.