Design for Special Hearing and Communication Needs

Presented by

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My background

PhD with Prof. Bridget Shield (LSBU)

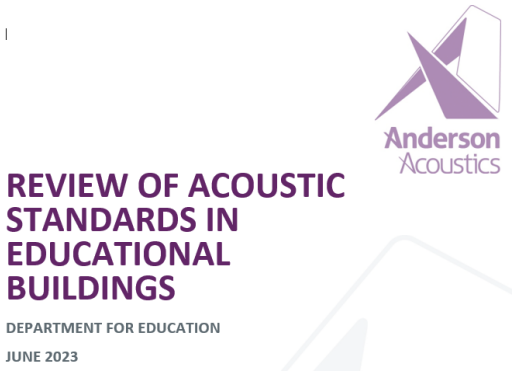
Co-author, Building Bulletin 93 & IoA/ANC Design Guide

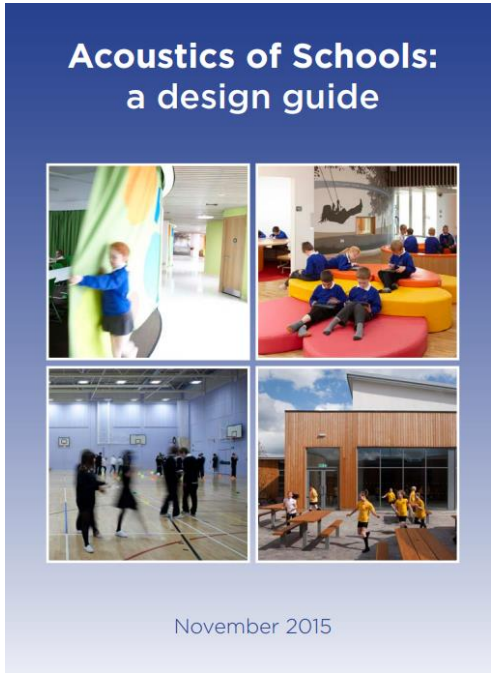
Subject Matter Expert for 2022 DfE research project

SEND Governor, local primary school

Pre-School Chair of Trustees

Advocate for equal access to listening



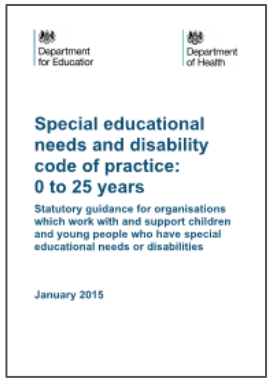


1. What we should do
2. What happens in practice
3. Criteria (classrooms and other areas)

1. What we should do

1. What we should do

1a. Understand all requirements and Equality duties (Equality Act, SEND Code of Practice, DfE Output Specification, School Premises Regulations, Schools SEND information Report, School Accessibility Plan, LA Accessibility Strategy, Ordinarily available provision)

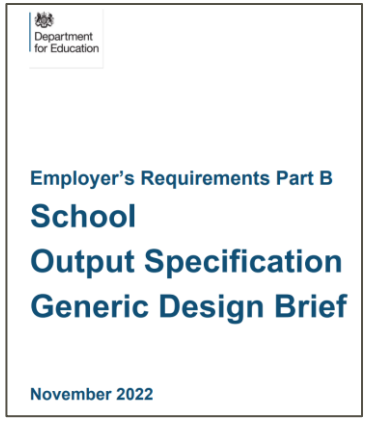


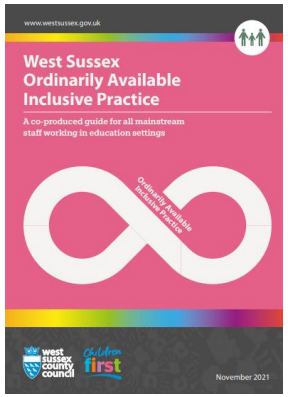
- They **must** make reasonable adjustments, including the provision of auxiliary aids and services, to ensure that disabled children and young people are not at a substantial disadvantage compared with their peers. This duty is anticipatory – it requires thought to be given in advance to what disabled children and young people might require and what adjustments might need to be made to prevent that disadvantage

auxiliary aids and services. Most providers **must** also make reasonable adjustments by making physical alterations. Schools and local authority education functions are not covered by this last duty, but they **must** publish accessibility plans (and local authorities, accessibility strategies) setting out how they plan to increase access for disabled pupils to the curriculum, the physical environment and to information.

Who?
How many?

'People with disabilities, including those with hearing impairment, must not be placed at a disadvantage by the design of the Building





The term 'ordinarily available provision' comes from the SEN Code of Practice and refers to the support that mainstream schools or settings should be able to provide for a child or young person through their agreed funding and resource arrangements.

Quantify?

180 pupils a day in England given special needs support plan

Local authority deficits reach 'unmanageable levels' as half a million pupils get support

Last year, 66,356 children and young people started new EHCP plans. Photograph: Graeme Robertson/The Guardian

The number of pupils in England issued with a special needs support plan has more than doubled in the last eight years to 180 a day, driving up deficits in local authority budgets to "unmanageable levels", according to analysis.

A record half a million pupils have an education, health and care plan (EHCP), a legal document setting out a child or young person's special educational needs, the support they need, and the outcomes they would like to achieve.

Disruptive behaviour leaves excluded pupils' units in England 'full to bursting'

Referral unit providers warn of overwhelming demand from unprecedented poor behaviour after pandemic lull

When schools look for support, often there is no one there. Photograph: MBI/Alamy

Referral units for children who have been excluded from mainstream schools are warning that they are full to bursting because of unprecedented levels of disruptive behaviour across the country.

Providers that take children excluded from mainstream schools say that after a lull during the pandemic, the situation has deteriorated, and they have seen permanent exclusions rising across the country in the past year. The situation had appeared to be improving with the latest government data on permanent exclusions in England showing that they fell in the spring term last year to 2,200 from 2,800 in 2019.

Many councils have pupils permanently outside the general schools system with nowhere to go, and they are asking pupil referral units (PRUs) to take more despite being full.

The Guardian

1. What we should do

1b. Anticipate SHCN as a need in every mainstream classroom (Universal Design approach)

Building Bulletin 93 definition:

***S**pecial*
***H**earing and*
***C**ommunication*
***N**eeds*

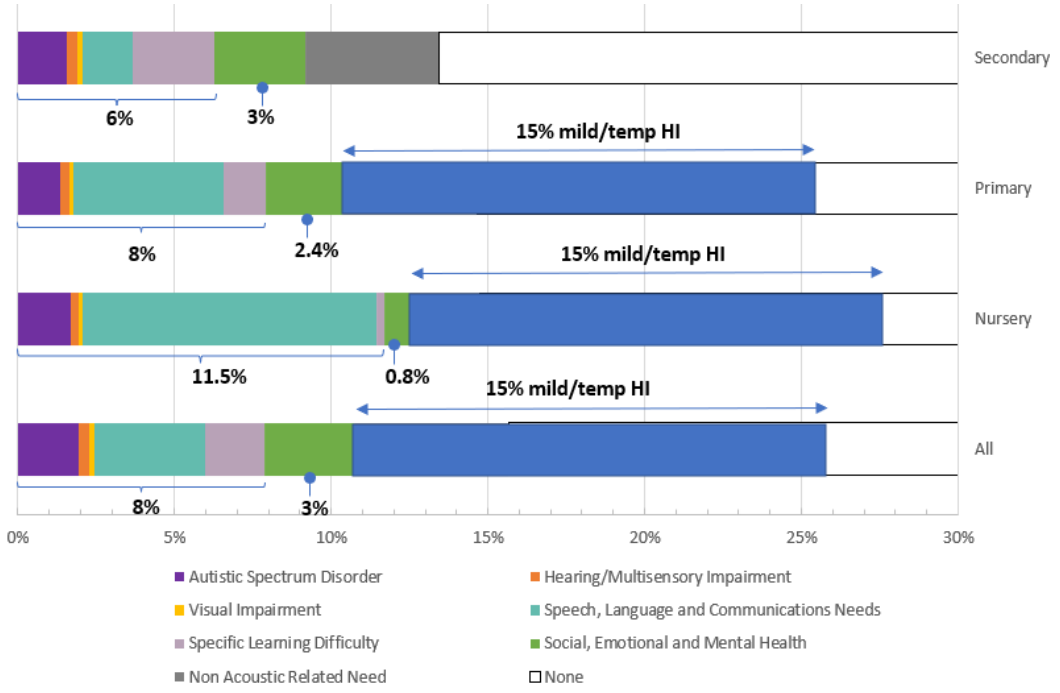
- Permanent hearing impairment
- Mild or temporary hearing impairment
- Speech, language & communication needs, SLCN
- AD/HD, Autistic spectrum disorder
- Auditory processing disorder
- Visual impairment

Equality Act (protected groups)

- Age discrimination
- English as Additional Language (EAL)

Since BB93 2015: Social Emotional Mental Health needs, SEMH
Dyslexia,
Developmental Language Delay
Specific Language Impairment

"In order to fulfil their duties under the Equality Act 2010, school client bodies should anticipate the needs of deaf and other disabled children as current and potential future users of the school". **(Building Bulletin 93)**



1. What we should do

1c. Recognise Early Years as a type of SHCN (however in practice acoustic standards remain unregulated)

Daycare facilities = highest noise levels (up to 85 dBA)

Younger children (3-5 years) have a speech perception deficit in noise

Lower noise in daycare (via absorbent finishes) linked to improved listening skills and wellbeing in children. (pre-reading/language/ attention/persistence)

Speech Language and Communication Needs (SLCN) is most prevalent form of SEN (& EAL is most prevalent in nursery sector)

Young children lack phonological awareness, auditory processing, sentence recall skills, or discipline to focus on a task in presence of noise

Mild/Temporary hearing loss is highly prevalent

1. What we should do

1d. Understand the needs of your school cohort:

PMLD, AP, PRU, SEMH, ASD, COINS, SpLD, SLD……..

- ***Listening needs***
- ***Listening Disadvantage***
- ***Behaviours***
- ***Communication scenarios***
- ***Classroom organisation***
- ***Classroom management***

Need	Broad Area of SEN	Listening Disadvantage	
		Inherent gap (ideal conditions +15-20 dB SNR, 0.3-0.5s RT)	In active classroom (0 dB SNR)
OME	N/A	not quantified	
$HI_{min-mild}$	Sensory	4-5%	18-26%
$HI_{mild-mod}$	Sensory	6-7%	19-35%
HI_{S-P}	Sensory	9-12%	46-66%
ASD	COINS	not quantified (+2 to +3.5 dB SNR needed)	10%
APD	COINS	not quantified (+7 dB SNR needed)	
SLCN	COINS	see DLD,SLI	
AD/HD	SEMH	0%	34%
SEMH	SEMH	not quantified	
Dyslexia	SpLD	0%	9-11%
DLD, SLI	SpLD	5-6% (SLI, DLD)	25% (SLI)
EAL	N/A	1-4%	8-12%

**Dyslexia results debated, may be co-morbid with other needs*

1. What we should do

1e. Recognise the following needs as a type of SHCN:

- ***English as an Additional Language***
- ***Dyslexia & Developmental Language Delay***
- ***SEMH***

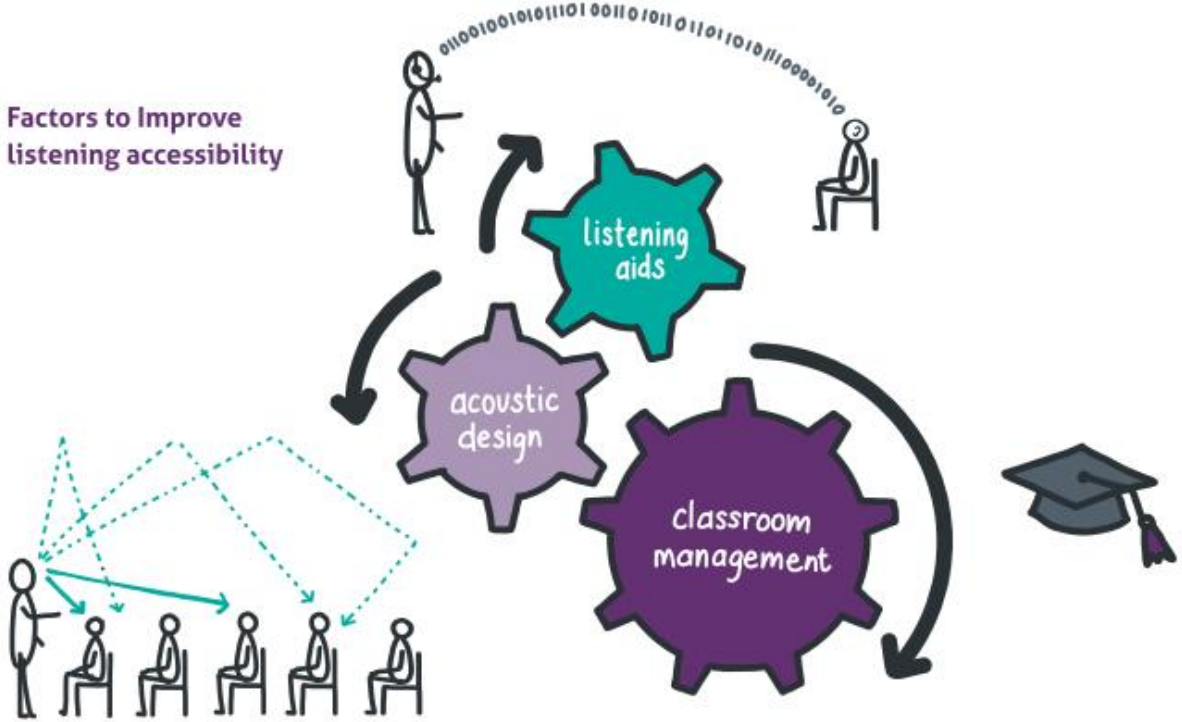
"A listening disadvantage of 8-11% was reported even for truly bilingual adult listeners who demonstrate equal proficiency in both languages and acquired their language prior to 6 years old.

Furthermore, EAL listeners have longer reaction times and pupillometry responses on tasks (symptomatic of extra listening effort), even when listening in quiet. This may result in increased fatigue and a reduced ability to successfully perform multiple tasks simultaneously.

So children with EAL may still be considered to have SHCN, owing to the extra listening effort expended even in quiet conditions, and the reduced speech perception capability in noisy active conditions".

1. What we should do

1f. Consider acoustic design in the context of other factors. Role of classroom management and technology.



1. What we should do

1g. Use the DfE SoA/ADS (Data Library) to inform SEN room acoustic design?

Key Data

SCHOOL :						Activity noise level	Noise tolerance	Maximum reverberation time	
Parent ADS code	Final ADS code	Room Code for individual space	Unique name of individual space	New / Remodel / Keep / Refurb		ER advice	ER advice	ER type if new	ER type if refurb
RES14	RES14	3007	Recording control space 1	NEW		High	Low	<=0.5	<=0.6
RES16	RES16	3008	Lighting and audio control space 1	NEW		Average	Medium	<=0.8	<=1.0
RES16	RES16	3008	Lighting and audio control space 2	NEW		Average	Medium	<=0.8	<=1.0
SEN02	SEN02	3009	Medical treatment (MI) room 1	NEW		Low	Medium	<=0.4*	<=0.4*
SEN02	SEN02	3010	Medical treatment (MI) room 2	NEW		Low	Medium	<=0.4*	<=0.4*
SEN20	SEN20	3011	SEN resource space 1	NEW		Low	Medium	<=0.8	<=1.0
SEN20	SEN20	3012	SEN resource space 2	NEW		Low	Medium	<=0.8	<=1.0
RES00	RES00	3013	Small group room 1	NEW		Average	Medium	<=0.6	<=0.8
RES00	RES00	3014	Small group room 2	NEW		Average	Medium	<=0.6	<=0.8
RES00	RES00	3015	Small group room 3	NEW		Average	Medium	<=0.6	<=0.8
RES00	RES00	3016	Small group room 4	NEW		Average	Medium	<=0.6	<=0.8
RES00	RES00	3017	Small group room 5	NEW		Average	Medium	<=0.6	<=0.8
RES00	RES00	3018	Small group room 6	NEW		Average	Medium	<=0.6	<=0.8
RES00	RES03	3019	Small group room (medium) 1	NEW		Average	Medium	<=0.6	<=0.8
RES00	RES03	3020	Small group room (medium) 2	NEW		Average	Medium	<=0.6	<=0.8
RES00	RES03	3021	Small group room (medium) 3	NEW		Average	Medium	<=0.6	<=0.8
RES00	RES04	3022	Small group room (large SEN etc.) 1	NEW		Average	Medium	<=0.6	<=0.8

Key Data

SCHOOL :			Insert Name of School or Project		Type of heating and ventilation control	Activity noise level	Noise tolerance	Maximum reverberation time	Maximum reverberation time
Parent ADS code	Final ADS code	Room Code for individual space	Unique name of individual space	New / Remodel / Keep / Refurb	CP description of solution	ER advice	ER advice	ER type if new	ER type if refurb
RES50	RES50	3044	Small Group Room			Low	Medium	<=0.4*	<=0.4*
RES50	RES50	3045	Small Group Room			Low	Medium	<=0.4*	<=0.4*
RES50	RES50	3046	Small Group Room			Low	Medium	<=0.4*	<=0.4*
			deleted line						
SEN13	SEN13	3047	SALT 1:1			Low	Medium	<=0.4*	<=0.4*
SEN13	SEN13	3048	SALT 1:1			Low	Medium	<=0.4*	<=0.4*
SEN13	SEN13	3049	SALT Resource Room			Low	Medium	<=0.4*	<=0.4*
SEN13	SEN13	3050	SALT Therapy Room			Low	Medium	<=0.4*	<=0.4*

1. What we should do

1h. Write a well justified acoustic performance standard:

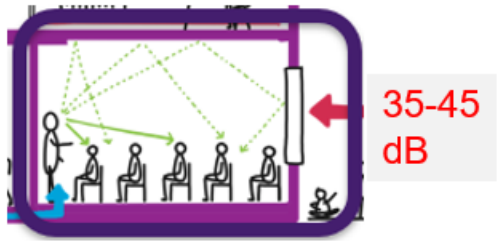
- ***Educational (Classroom operation, communication scenario)***
- ***Health and Safety (Flooring finish, Supervision)***
- ***Environmental (Thermal cooling, natural ventilation)***

Evidence based justification

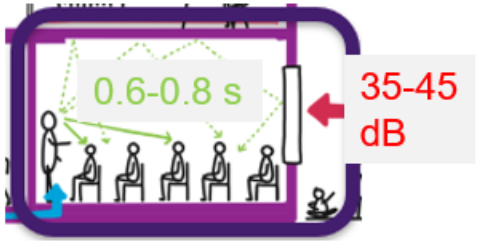
2. What happens in practice

1. What happens in practice

1a. Reach for Building Bulletin 93 and limit to BB93 definition of SHCN:

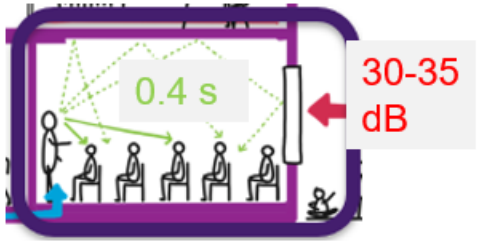


Mid frequency T_{mf} control only



Shorter RT, mid-frequency T_{mf} control only

'Rooms specifically designed for SHCN'



Even shorter RT!
+control at 125Hz
Lower ambient noise

...if inclusion is such an important issue, can't we just apply the SHCN enhanced standard to all mainstream classrooms?

Anderson Acoustics

1. What happens in practice

1b. Discover design constraints:

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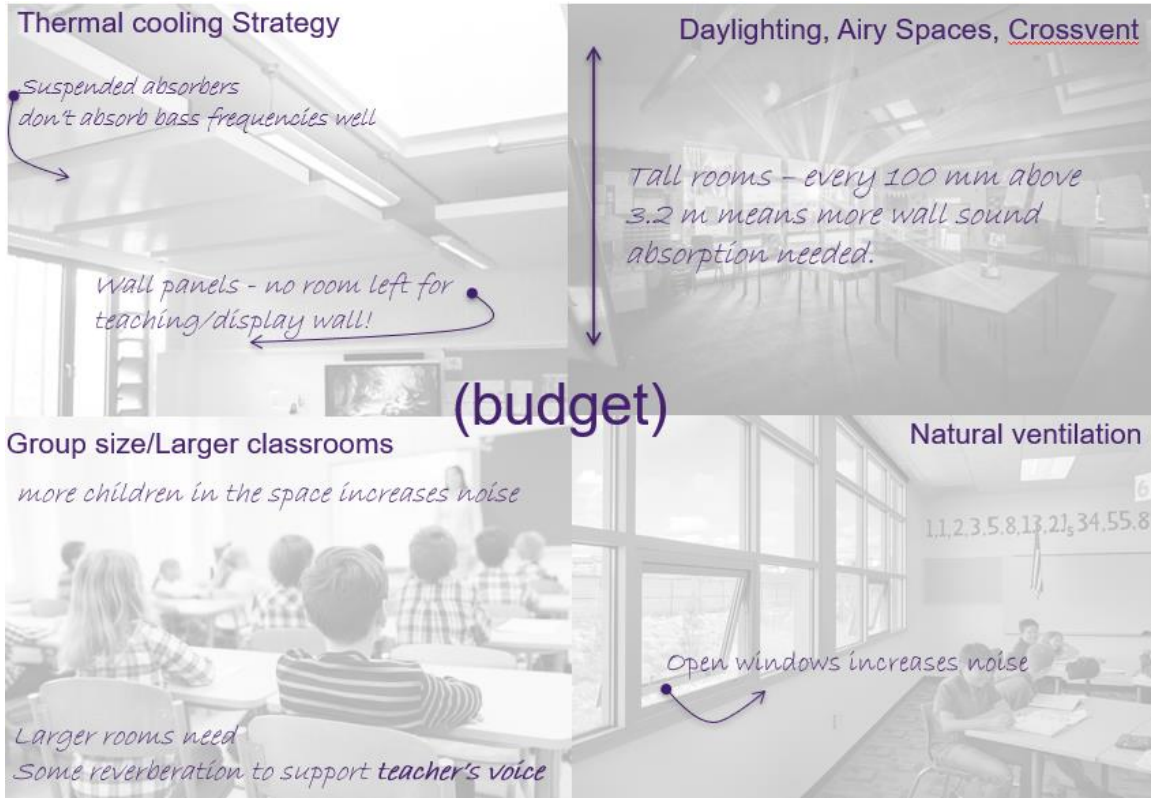


1. What happens in practice

1c. Alternative Performance Standard raised, sometimes light on technical justification

Budget is sometimes the underlying reason for the APS, instead of

- ***Education***
- ***Health and Safety***
- ***Environmental need***

1d. School Premises Regulations get ignored:
'We just want to comply with Approved Document E'.
Many spaces slip through the net:

- ***Refurbishment***
- ***'Temporary' Classrooms***
- ***After School Clubs***
- ***Nurseries (external provision)***
- ***Offices/Dining/non-teaching and learning spaces***

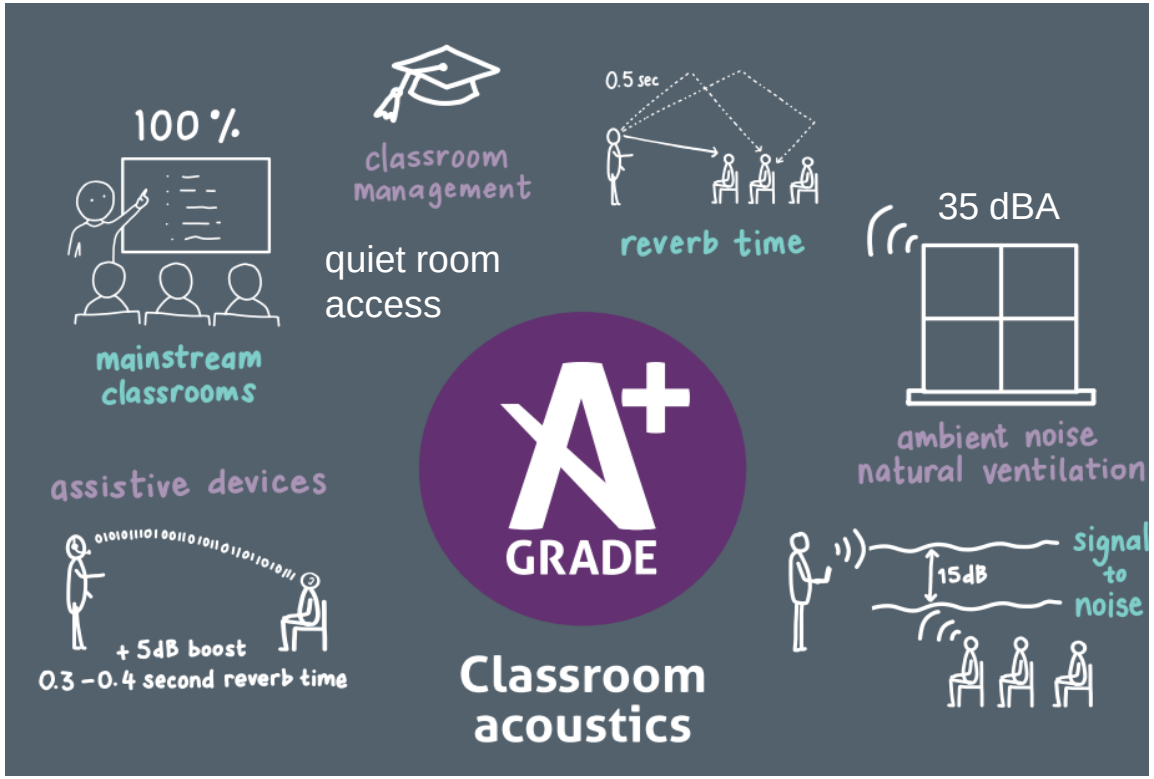
1. What happens in practice

1d. Some needs are missed causing a listening disadvantage as they currently fall outside scope of BB93:

- ***Early Years (where nurseries are out of scope of BB93)***
- ***SEMH within mainstream classrooms***
- ***AD/HD, ASD, APD, SLCN in mainstream classrooms***
- ***Dyslexia/Developmental Language Delay***
- ***English as additional language***

3. Criteria (classrooms and other areas)

3. Criteria (classrooms - mainstream)



3. Criteria (mainstream classrooms)

Justification for reasonably adjusted standard:

- Teachers voice protected at 0.5 s RT
- 0.5 s and 35 dBA linked to suitable control of activity noise levels:
- 64 dBA (good for reading, below trigger for ASD repetitive behaviours)
- Keeps active lesson SNR to around 0 dBA,
- Listening aid minimises listening disadvantage for broader needs at this SNR
- Shorter effective RT (0.4s) and SNR boost (+20 dB SNR) can be achieved with a listening aid
- Quiet pods/escape spaces provide an alternative choice when noise levels are too much in active classroom

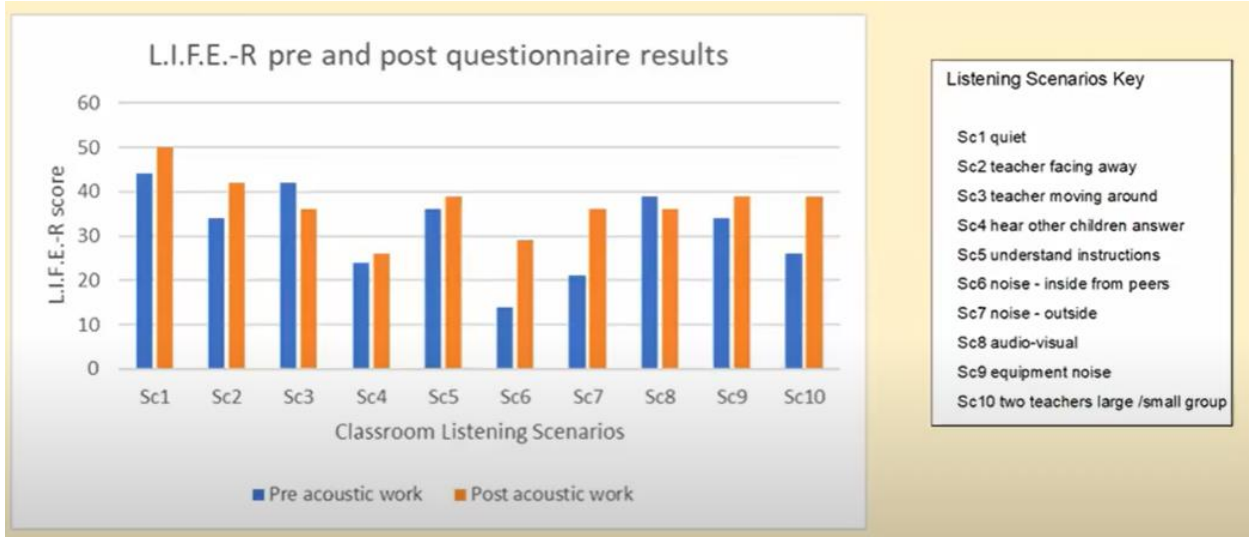
Shield, B., Conetta, R., Dockrell, J., Connolly, D., Cox, T. and Mydlarz, C., 2015. A survey of acoustic conditions and noise levels in secondary school classrooms in England. *JASA*, *137*(1), pp.177-188.

Connolly, D., Dockrell, J., Shield, B., Conetta, R., Mydlarz, C. and Cox, T., 2019. The effects of classroom noise on the reading comprehension of adolescents. *JASA*, *145*(1), pp.372-381.

Shield, B.M. and Dockrell, J.E., 2008. The effects of environmental and classroom noise on the academic attainments of primary school children. *JASA 123*(1), pp.133-144.

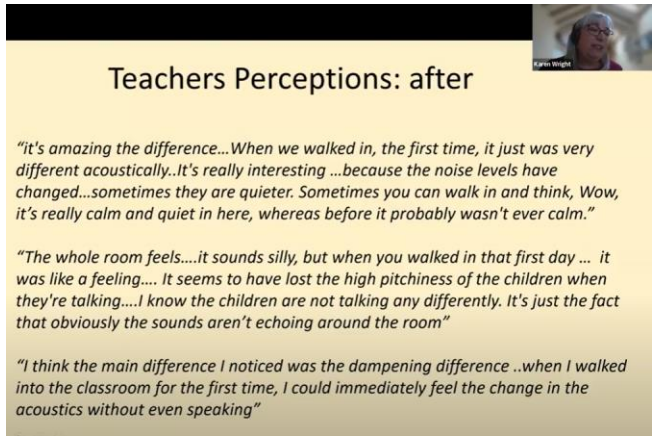
3. BAEA Case Study (Karen Wright)

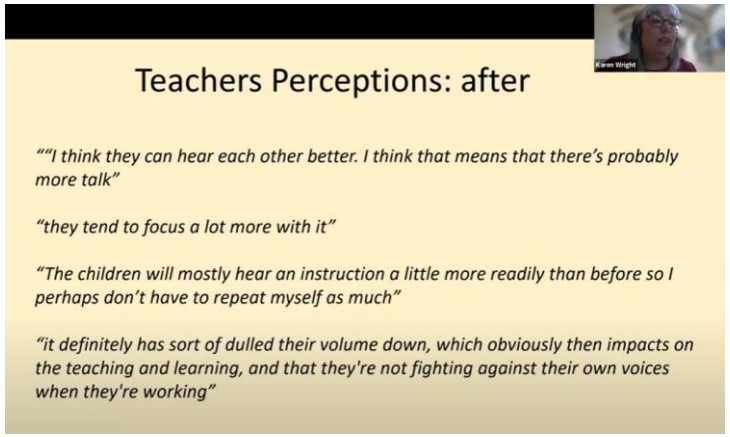
- 10 mainstream classrooms; 8 pupils with hearing aids/CI and using assisted listening device
- Intervention: Acoustic wall panels fitted in addition to existing acoustic ceilings (to < 0.4s T_{mf})
- 5 valid pre/post pupil questionnaire responses & teachers interviewed

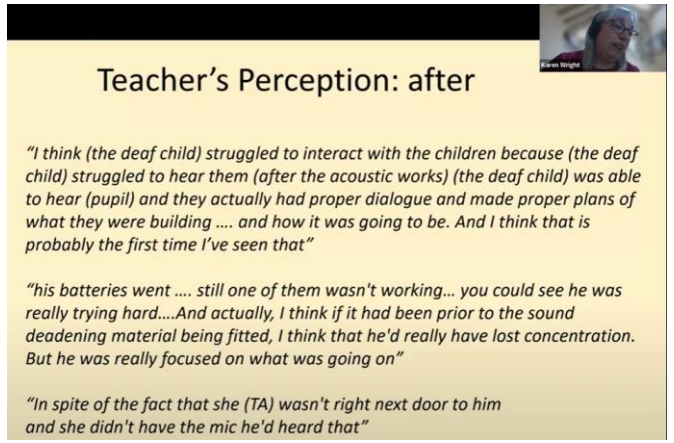


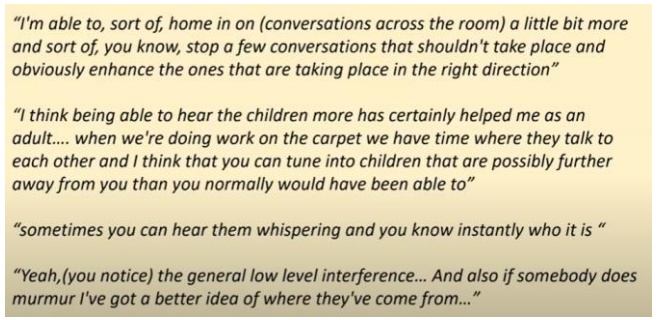
3. BAEA Case Study (Karen Wright)

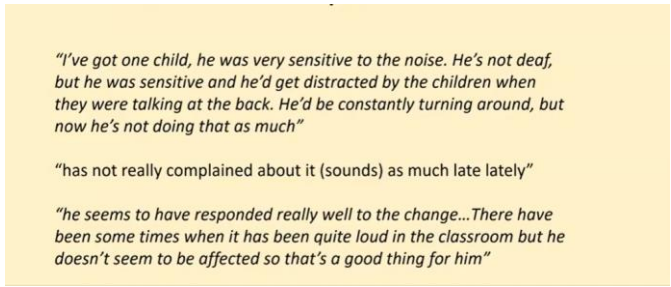
- **Recommendation: Link up with BAEA to jointly explore impact of 0.5 s T_{mf} & T_{125Hz}**

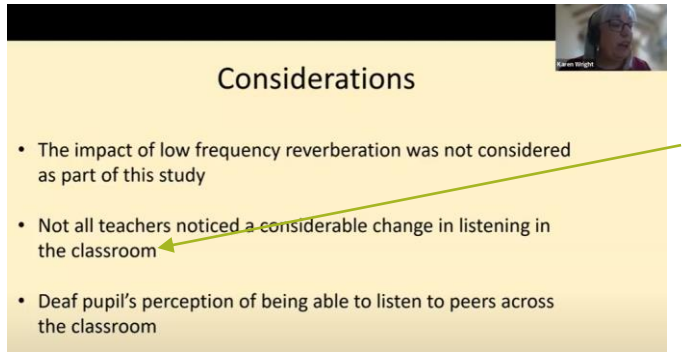












Pre intervention RT was shorter in these classrooms (0.5 s RT?)

3. Criteria (HI & SALT)

When should the original BB93 SHCN standard be adhered to?

- Schools for the deaf
- Dedicated HI units within mainstream
- To offer respite to listen and learn without hearing aids or listening aids (can be tiring)
- Speech and Language therapy Rooms?

- Other scenarios???

3. Criteria (other spaces, Sports Halls, Dining)

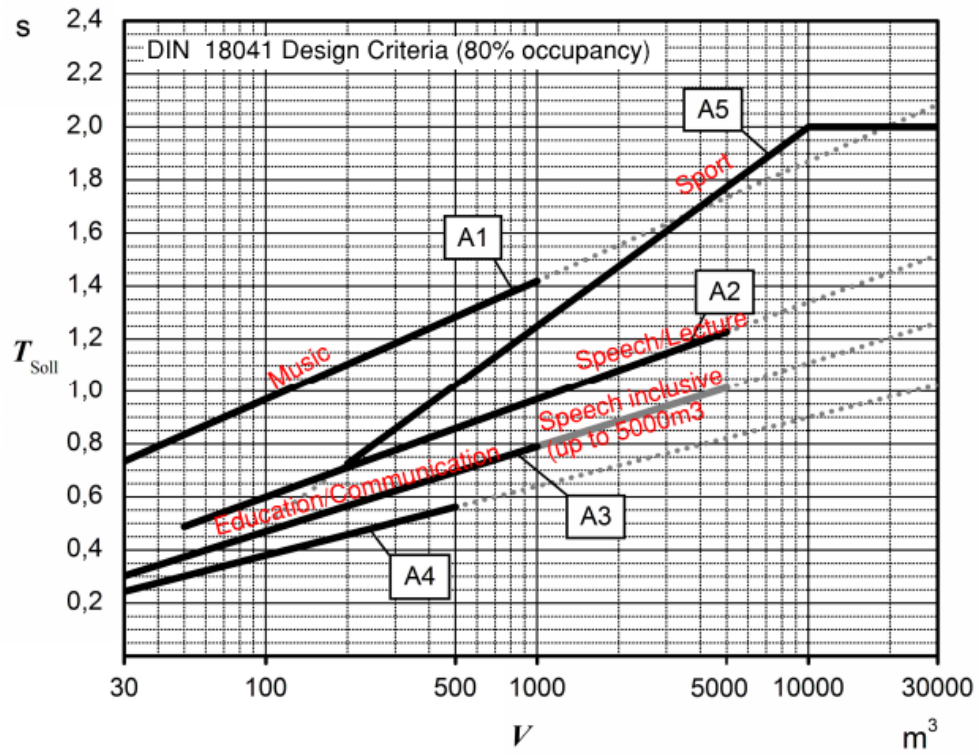
BNAM2012
Joint Baltic-Nordic Acoustics Meeting
June 18th - 20th 2012 Odense, Denmark

Acoustical capacity as a means of noise control in eating establishments

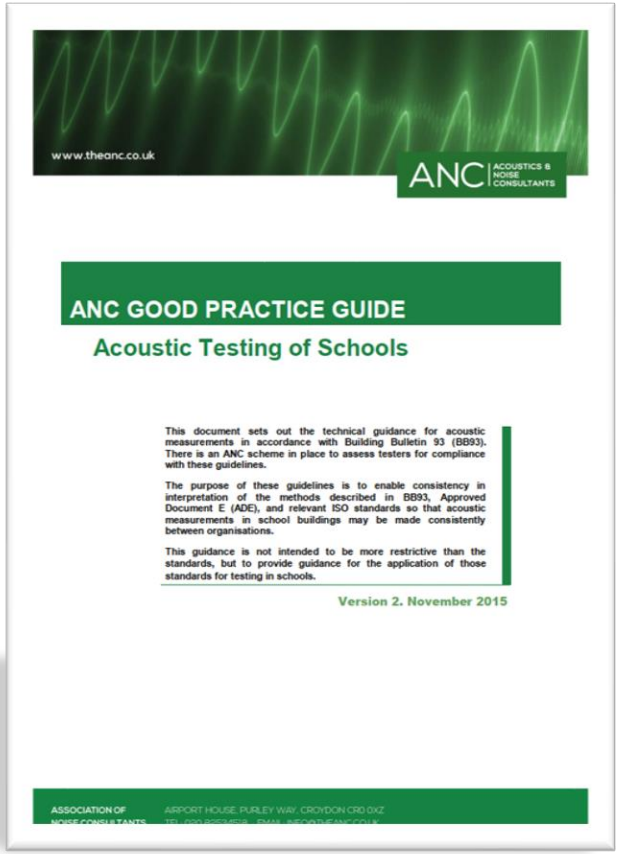
Jens Holger Rindel
Odeon A/S, Scion-DTU, Diplomvej 381, DK-2800 Kgs. Lyngby, Denmark, jhr@odeon.dk

Noise from many people speaking in eating establishments and other social gatherings is a well known and wide spread problem. The problem is particularly difficult to handle because the sound sources are individual and dynamic, i.e. the speech level increases when the ambient noise level goes up. However, a simple prediction model has been derived that allows estimating the ambient noise due to speech from a large group of people, the main uncertainty being the so-called group size, i.e. the average number of people per speaking person. As a measure of the acoustical quality is suggested the average signal-to-noise ratio when listening to a person speaking to you in a distance of 1 m and the ambient noise is that from other people speaking in the room. The Acoustical Capacity is defined as the number of people that would create a signal-to-noise ratio of -3 dB, which is considered the lower limit for "sufficient" quality of verbal communication under certain preconditions. The Acoustical Capacity is calculated from volume and reverberation time by a very simple equation. The acoustical quality of an eating establishment may be characterized by the ratio between the Acoustical Capacity and the total capacity.

DIN 18041:2016-03



Acoustic Design and Testing of Schools



Acoustic commissioning

Jack Harvie-Clark

From client's perspective, why require acoustic commissioning?

- To ensure compliance with Building Regs?
- To ensure that the design achieves the targets?
- To find out if the design worked?
- So that the contractor builds the design?
- Other?

What are the pressing issues around acoustic commissioning?

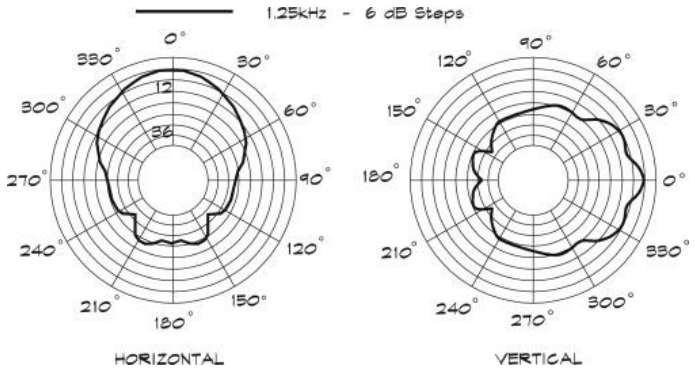
Reverberation times: room condition

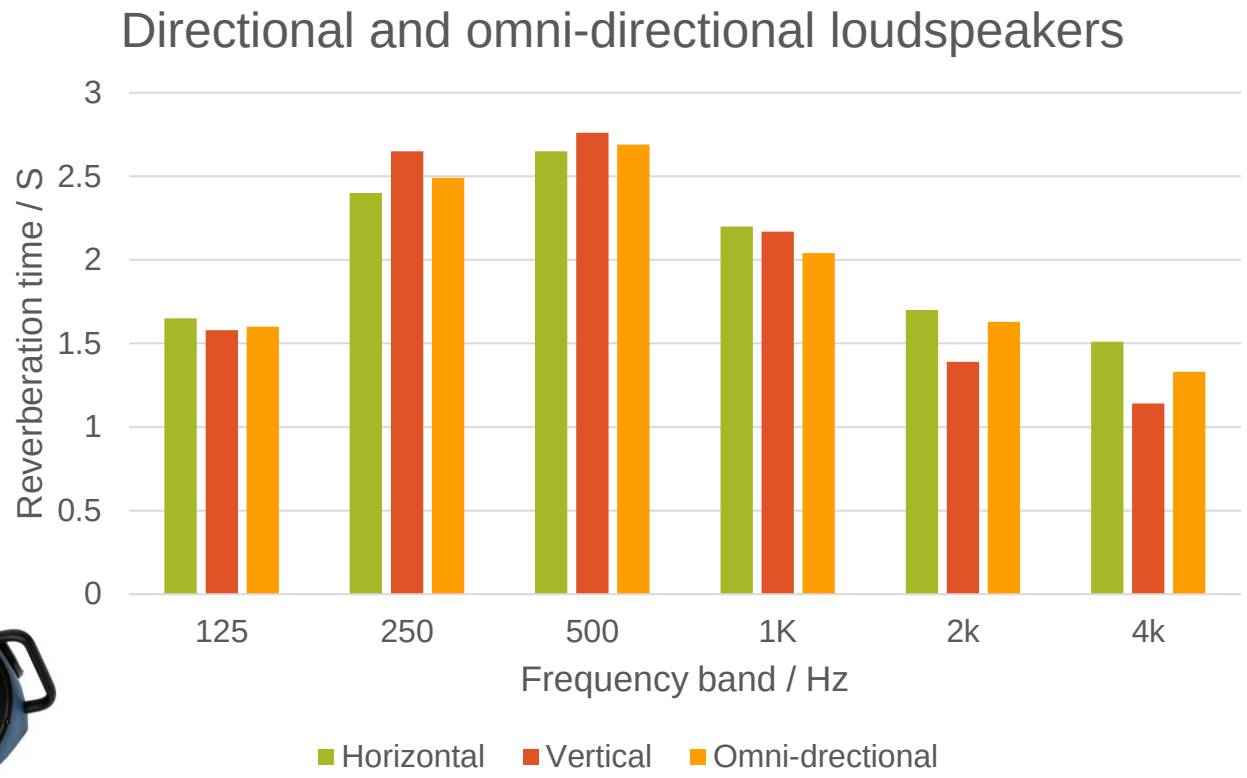
- *There should be no more than one person present in the room during the measurements.*
- *The performance standards for mid-frequency reverberation times relate to **finished, unoccupied, and normally furnished rooms**. Any deviation from these room conditions during the testing should be recorded in the test report.*

Reverberation times: room condition

- There is usually furniture in the room when we test
- If there's no furniture and it's a marginal failure, we indicate that it's likely to pass when furnished
- We use diffusers to simulate furniture
- We use sheets of board materials leant against the walls
- We have investigated diffuser effectiveness
- We need better guidance on room conditions for consistency

Reverberation times: measurement method





Reverberation times in school halls: measurement oddities and modelling. D Wallace, J Harvie-Clark. Forum Acusticum, 2014

Reverberation times: measurement method

- Impulse response
- Interrupted noise
- Omni-directional loud speaker with interrupted noise
- Careful orientation of directional loud speaker
- We should use omni-directional loudspeakers in non-diffuse rooms

What to commission? Do you:

- Test at least one in four teaching rooms (rounding up) for sound insulation, reverberation time and ambient noise levels?
- Select a representative sample of each different construction type and acoustic performance requirement?
- Include tests of different room types
- Use the “Design Guide method for sports halls…” for multi-purpose halls?

If not, is this because:

- It's not practically possible due to time constraints?
- It's not practically possible due to availability of rooms?
- We prefer to undertake fewer tests?
- We prefer not to, as some tests are more likely to fail?
- It's not commercially viable (ie too expensive) to test that much?
- Nobody is checking?
- The Design Guide refers to " other normally unfurnished activity spaces…"

Airborne sound insulation testing

Do you use:

- ISO 16283-1?
- ISO 140-4?
- An omni-directional sound source?

Airborne sound insulation testing

- Is it important to comply with ISO 16283-1
- We know the differences between ISO 16283-1 and ISO 140-4 for testing schools

Gap analysis: ISO 140-4 to 16283-1

BS EN ISO 140-4	BS EN ISO 16283-1
4. Calibration checks not specific about change in levels	4.2 Limit for deviation of 0.5 dB between calibration checks
5. Diffusers recommended	6. Note 1: Diffusers not recommended
Speaker directivity not qualified.	**7.2.1 Omni-directional loud speaker required**
6.2 6 dB between adjacent third octave bands	7.2.1 8 dB between third octaves allowed
6.3.2a Fixed microphone positions not defined in relation to operators body.	7.3.1 Use hand microphone at arm's length for sound level and reverb time measurements (10.1)
Averaging serially measured level differences matter of contention and AD-E defines arithmetic mean.	7.3.4 Averaging of serially measured level differences uses different equation
6.6 Background noise correction not defined for individual or averaged levels.	7.5.8 Background noise correction defined better
6.6 No requirement to check background noise of operator	9.1 Background noise measurement observed aurally
No uncertainty reporting requirements	13 Uncertainty reported to ISO 12999-1
Guidance not present	**Annexe C: Informative additional guidance**

Consider Annexes C, D, E?

Where rooms are large, highly damped, or contain significant dimensions perpendicular to the separating partition, consideration should be given to the application of the guidance in these Annexes. Typical classrooms are often highly damped, and therefore the accuracy and repeatability of measurements may be improved by using the guidance in these annexes.

Consider Annexes C, D, E?

- We are aware of the guidance in Annexes C, D, E.
- We apply the guidance in Annexes C, D, E.

Reference reverberation time options

- Use $T_{mf,max}$ in all frequency bands
- Use the measured RT in each frequency band

Reference reverberation time

- It's useful to have two methods
- I'd prefer a single method
- Sometimes a marginal failure with one method is a marginal pass with the other method
- If I have to pick one, I'd prefer just the Standardised method with fixed RT
- If I have to pick one, I'd prefer the in-situ RT

Impact testing – ISO 140-7, 16283-2

BS EN ISO 140-7	BS EN ISO 16283-2
1. Building floors Doesn't specify… Doesn't specify Tapping machine only	1. Floor or stairs Room volumes in the range from 10 m^3 to 250 m^3 Frequency range from 50 Hz to 5000 Hz Furnished or unfurnished rooms Tapping machine or rubber ball
4. Sound level equipment class 0 or 1 to IEC 60651 and IEC 60804	4.1 Instruments including microphones, cables, windscreens, recording devices to Class 0 or 1 in accordance with IEC 61672-1 for random incidence application
4. Reverb time equipment to ISO 354	4.1 Reverb time equipment to ISO 3382-2
4. Complete measuring system calibrated before each measurement.	4.2 Calibrate at the beginning and end of every measurement session and at least at the beginning and end of each measurement day. SPL measured with calibrator noted. Difference between consecutive readings not to exceed 0.5 dB. Results after previous satisfactory check discarded if this isn't the case.
	4.3 Compliance of equipment with relevant requirements verified by a valid certificate of compliance
	Recommended that calibrator be calibrated at intervals not exceeding one year, instrumentation system (IEC 61672-1) not exceeding two years, filters – not exceeding two years
	5.2 Frequency range with rubber ball as source – 1/3 octave bands from 50 to 630 Hz

Impact testing – ISO 140-7, 16283-2

- The GPG should be updated to refer to ISO 16283-2
- Other issues with impact sound testing should also be addressed

Indoor ambient noise level

The design should show that IANLs can be achieved when the ventilation systems are operating in their normal condition; when providing intermittent boost ventilation; and when operating to control summertime overheating.

Measurements should be made in three positions that are normally occupied during teaching or study periods, including those closest to the most significant sources of noise, for each ventilation state

The windows or vents should be open as required to provide adequate ventilation outside the hottest 200 hours of the year. The mechanical engineers need to identify the extent of window or vent opening… it is suggested that all the opening lights are opened to half their full extent..

Table 2: summary of ventilation condition, system type and associated IANL tolerance

Condition	Ventilation system	Noise level limit
Normal - ventilation for normal teaching and learning activities	Mechanical[1]	Table 1 value
	Natural[2]	Table 1 value + 5 dB[4]
	Hybrid[2]	Mechanical system noise: Table 1 value
		Total noise level: Table 1 value + 5 dB
Summertime[5] - ventilation under local control of teacher to prevent overheating – allowable during the hottest 200 hrs of the year	Mechanical	Table 1 value + 5 dB[4]
	Natural or Hybrid	≤55 dB
Intermittent boost[6] – ventilation under local control of teacher for dilution of fumes during practical activities as in practical spaces for science, art, food technology and design and technology	Mechanical	Table 1 value + 5 dB[4]
	Natural	≤55 dB
Process - extract[3] can be automatic ventilation for safety and/or under local control of teacher	Mechanical and/or natural	See IoA/ANC guide[Ref1] for operational noise levels

IANL – natural ventilation

- We measure every aspect of the ventilation strategy inc. mixed modes
- We find out how far open the windows need to be for normal or summertime boost ventilation, and measure both conditions
- We usually take 5-minute measurement samples
- The guidance on measurement locations is sufficient
- Measuring during normal school hours is not a problem
- Sometimes we correct the measured IANL for anticipated RT when furnished and occupied

IANL – mechanical ventilation

- *… the mechanical systems should be controlled to operate at the design duty for the maximum occupancy of the room*
- *The method of controlling the ventilation system for the purposes of the test should be described in the test report*
- Three measurement positions are appropriate

IANL – mechanical ventilation

- We can reliably get the mechanical system suitably controlled
- Three measurement positions are appropriate
- There are other issues we need to address

Noise from window actuators

- Measured according to ISO 16032
- Limited to 5 dB above IANL
- Measurement based on reference installation allowable
- BB 93 refers to Acoustics of Schools: a Design Guide
- Have you used this guidance?

Noise from window actuators

- This guidance needs updating

STI in open plan spaces

- We test STI in open plan spaces
- The ANC GPG provides sufficient information to do this repeatably and reliably
- If we do test, it always passes

Reporting

- Any issues?

Competent persons scheme?

- A CPS would help achieve consistency between testers
- It would help keep the cowboys out
- It would let the SITMA testers in
- We would welcome a CPS if it were mandated by government, like for Building Reg.s