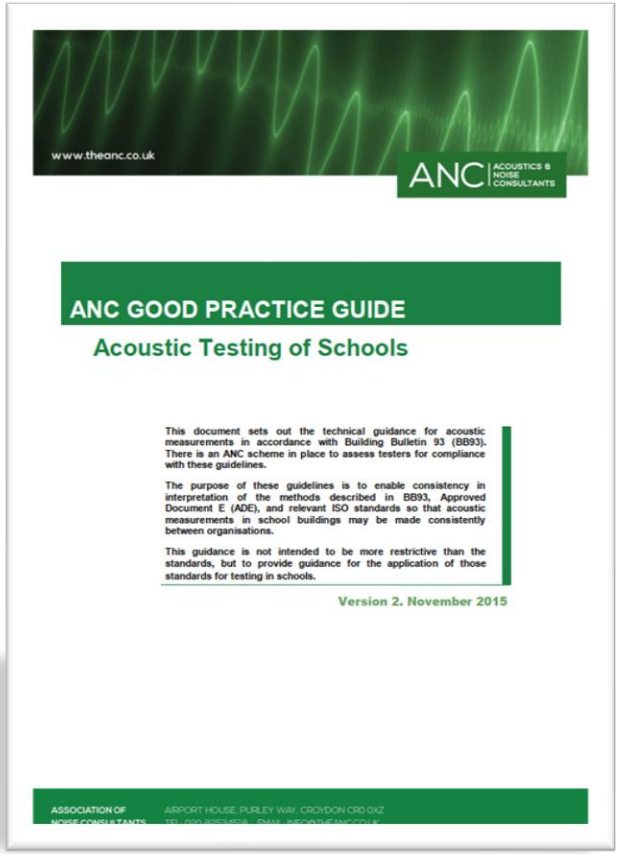
Acoustic Design and Testing of Schools



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?

- (Free text input)

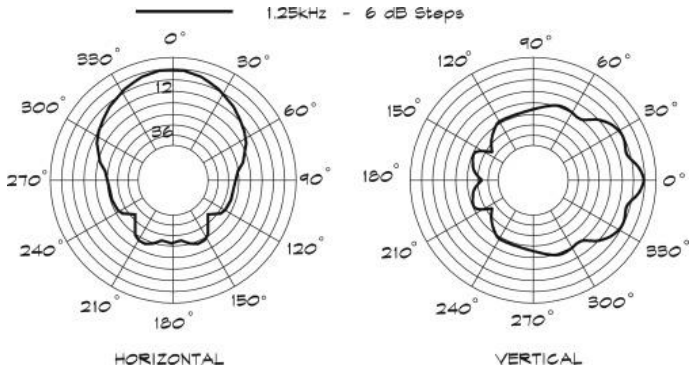
Reverberation times: room condition

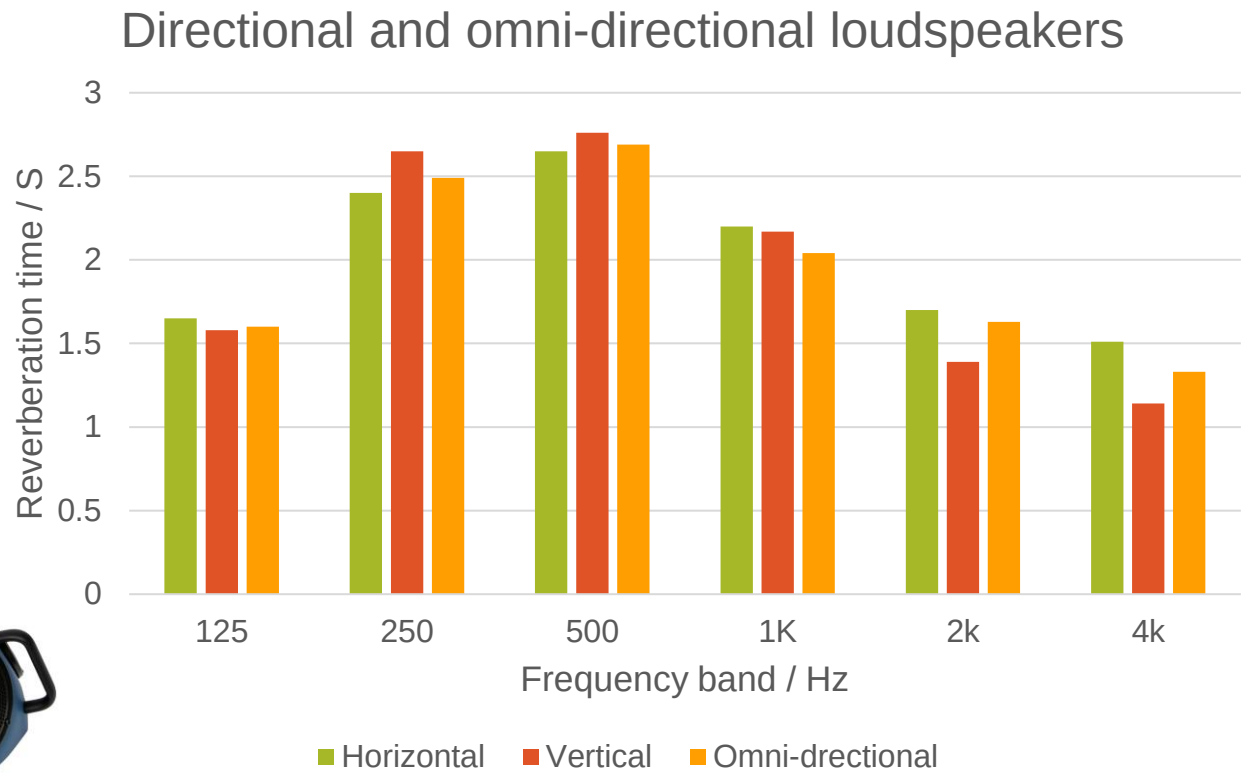
- *There should be no more than one person present in the room during the measurements.*
- *The performance standards for mid-frequency reverberation times relate to **finished, unoccupied, and normally furnished rooms**. Any deviation from these room conditions during the testing should be recorded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