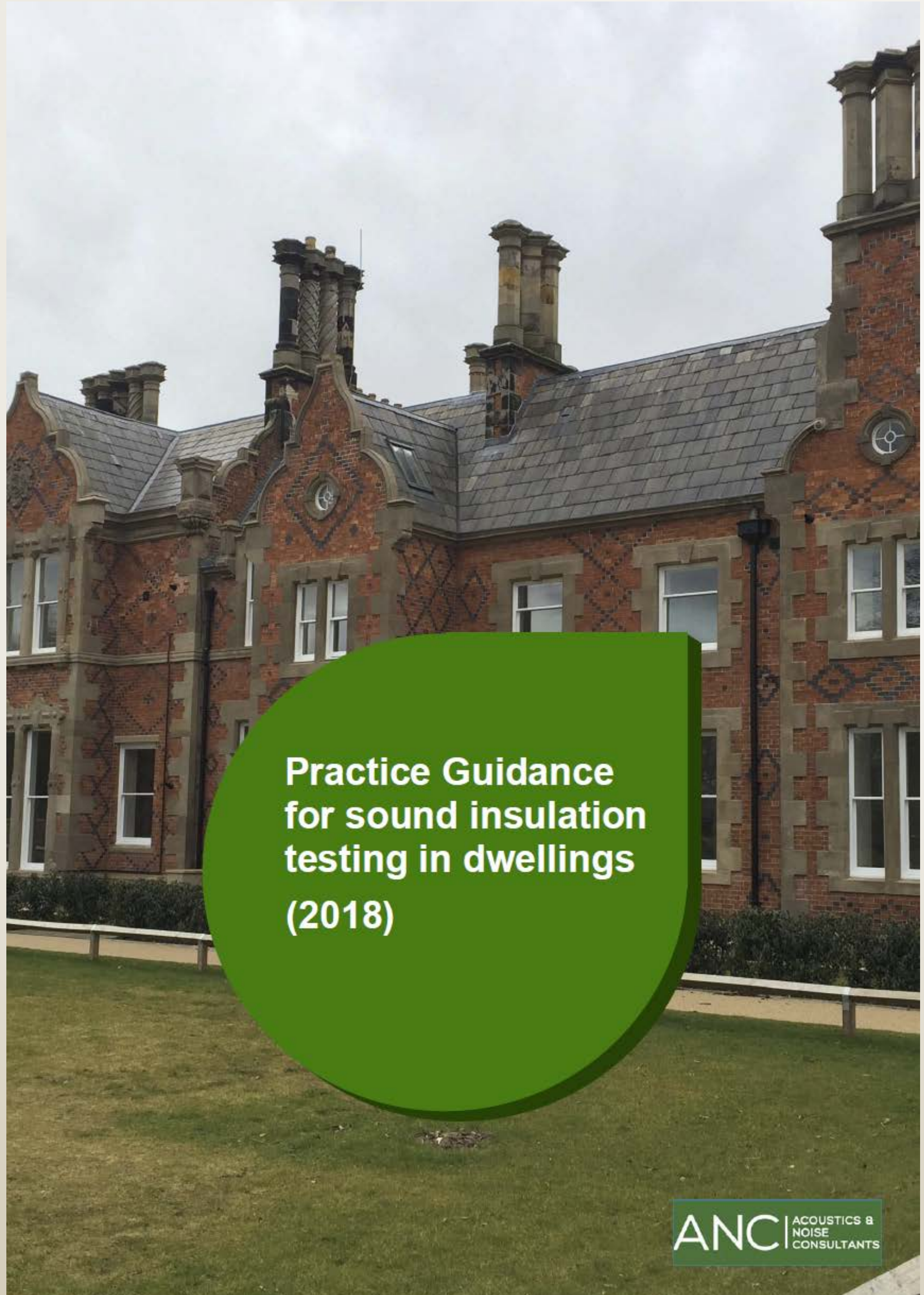
Engage brain and off we go!

Or – how the latest ANC Practice Guidance (2018) helps to reduce measurement uncertainty.

Iain Critchley MIOA (Chair of Certcomm)


Practice Guidance
for sound insulation
testing in dwellings
(2018)
ANC
ACOUSTICS &
NOISE
CONSULTANTS

References

- ISO 140-4:1998 (withdrawn 2014)
- ISO 140-7:1998 (withdrawn 2015)
- ISO 717-1:1997 (with 2006 amendment)
- ISO 717-2:1997 (with 2006 amendment)
- ADE Annex B 2003 (with 2004 amendment)
- ISO 140-14:2004 'Guidelines for special situations in the field' (withdrawn 2014)
- ISO 3382-2:2008 'Reverberation time in ordinary rooms'
- *ISO 16283-1:2014
- *ISO 16283-2:2015

(*Used as guidance – effectively replacing withdrawn ISO 140-14)

Test procedure (airborne)

1. Generate a ‘diffuse’ sound field in the source room.
2. Measure the sound field in the source room.
3. Measure the sound field in the receiver room.
4. Measure background noise.
5. Repeat 1, 2 and 3.
6. Measure Reverberation Time.

Final paragraph of Section 6.2 is probably the most important text in ISO 140-4:

"Place the loudspeaker enclosure so as to give a sound field as diffuse as possible and at such a distance from the separating element and the flanking elements influencing the sound transmission that the direct radiation upon them is not dominant.

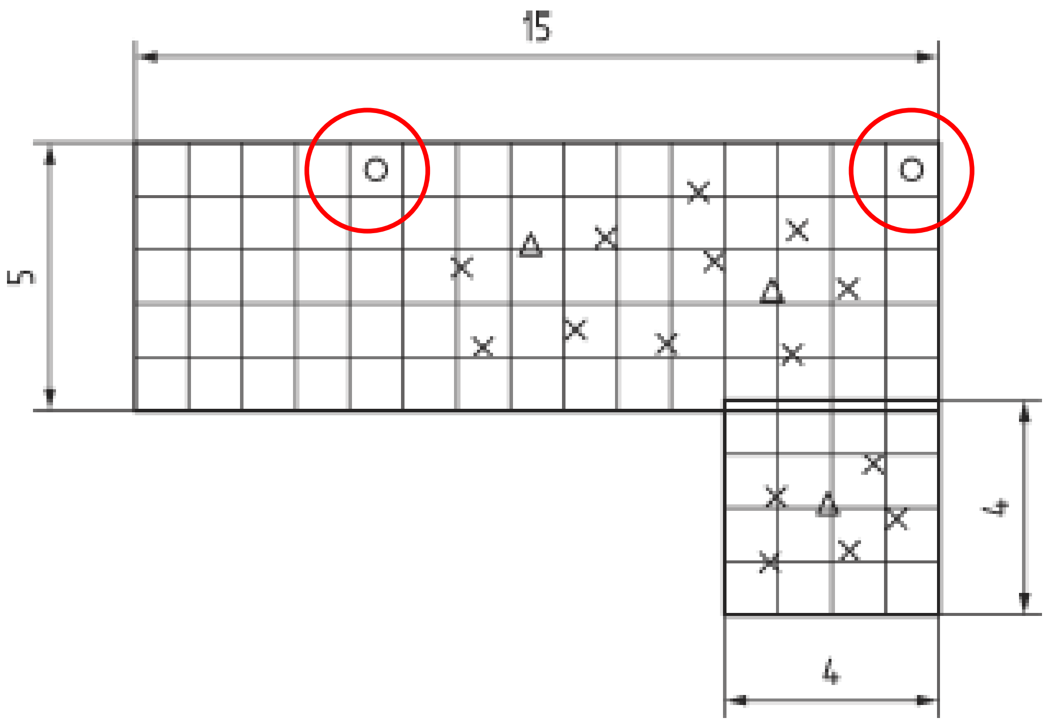
The sound fields in the rooms depend strongly on the type and on the position of the sound source.

Qualification of the loudspeakers and of the loudspeaker positions shall be performed using the procedures given in Annex A."

Dodec and Cabinet speakers

- Annex A of ISO 140-4 gives specifications for directivity of omni-directional (e.g. dodecahedron) sound sources in A.1.3.
- The wording of Annex A does, however, appear to allow directional (cabinet) loudspeakers but gives no guidance whatsoever on orientation.
- Only the ANC PG does this!

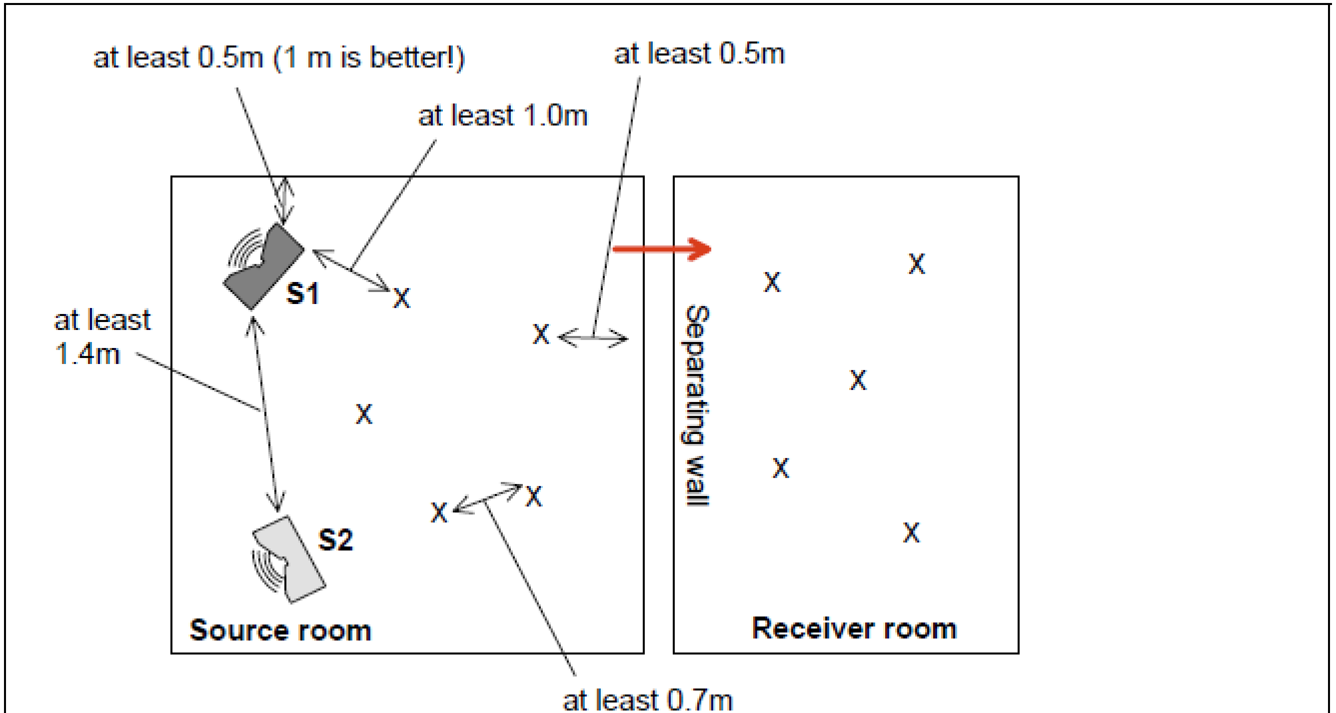
All official Guidance assumes omni-directional sound sources are used e.g. ISO 140-14



e) Example 5

1.Generate a 'diffuse' sound field in the source room to test a wall using a cabinet loudspeaker and broadband noise.

Figure 1 - Typical separating wall test arrangement (plan view)

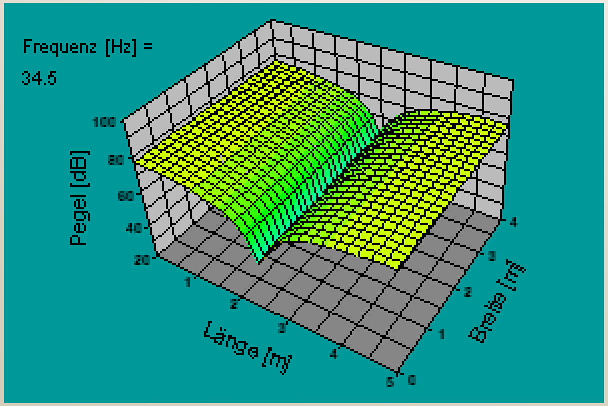


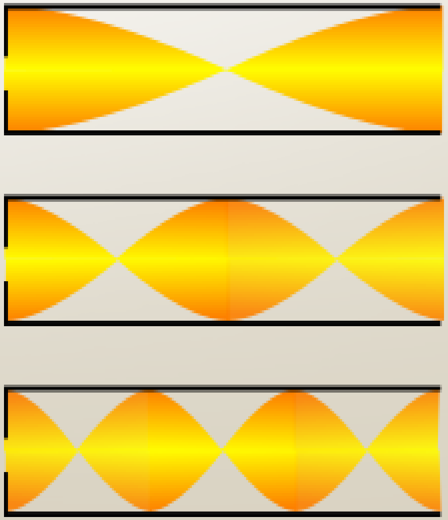
x = microphone positions for S1 (repeat for S2)

What is a ‘diffuse’ sound field?

(a little bit of room acoustics helps)

- Reflection, absorption and diffusion.
- Reverberation, resonance and damping
- Schroeder frequency
- Critical distance

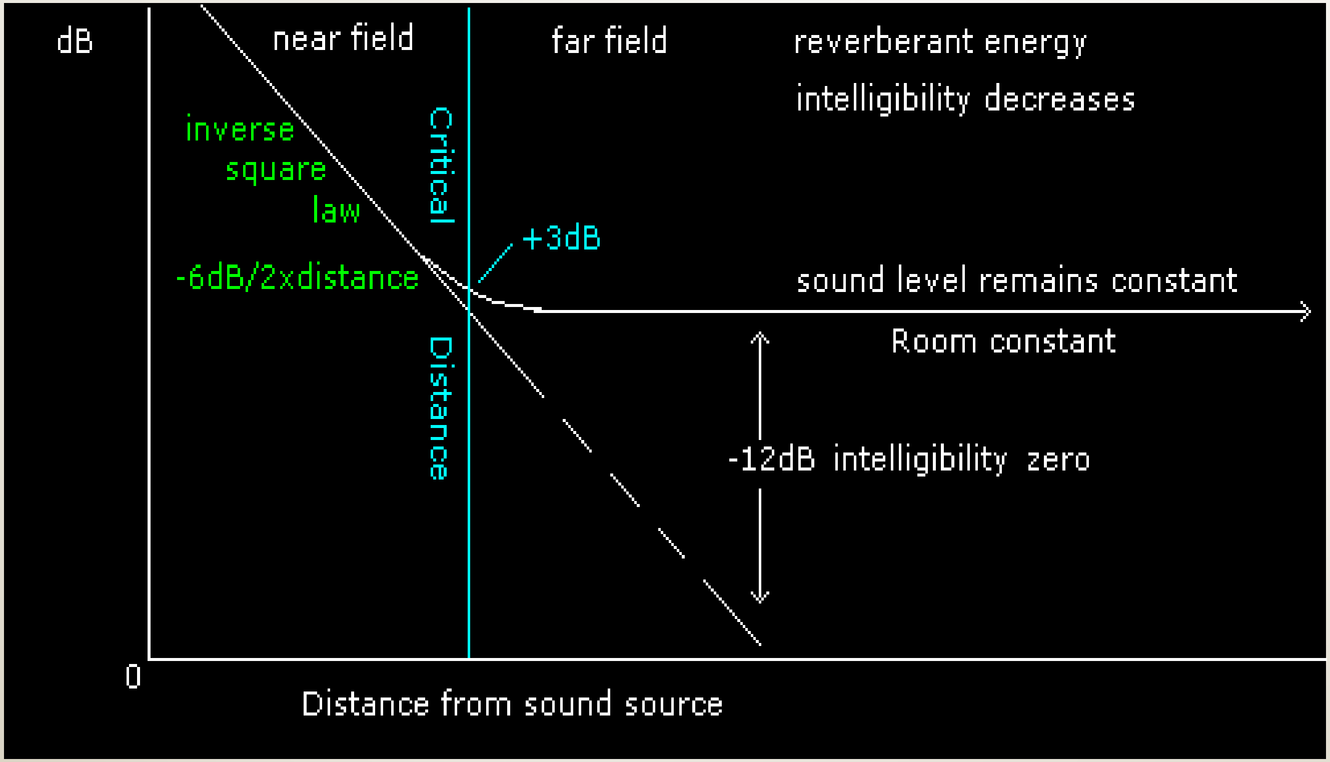




Schroeder Frequency

- At low frequencies, room resonances dominate where the room dimensions correspond to multiples of half a wavelength. The distribution of sound within the room is not uniform and 'modes' can occur.
- At mid and high frequencies sound is more uniform and behaves more like rays of light bouncing around the room.
- The 'crossover frequency' between these two phenomena is called the Schroeder Frequency (after Manfred Schroeder).
- $F_c = 2000\sqrt{T/V}$ Hz, where T is reverberation time and V is room volume
- A 30m^3 room with a 1.0 second RT has a Schroeder frequency of 365 Hz. The same room with a 0.5 second RT has a Schroeder frequency of 285 Hz.

Critical Distance



$D_c \approx 0.057\sqrt{QV/T}$, were Q is the directivity factor of the sound source and T is reverberation time.

Critical distance *<u>increases</u>* for shorter reverberation times.

For an **omnidirectional** sound source Q = 1 at all frequencies.

For a 30 m^3 room with a 1 second RT, the critical distance is 0.3 metres

Q is frequency dependent. For a **cabinet loudspeaker** Q = 1 at low frequencies but can be 16 or higher at 3.15 kHz.

For a 30 m^3 room with a 1 second RT, the critical distance is typically 1.2 metres.

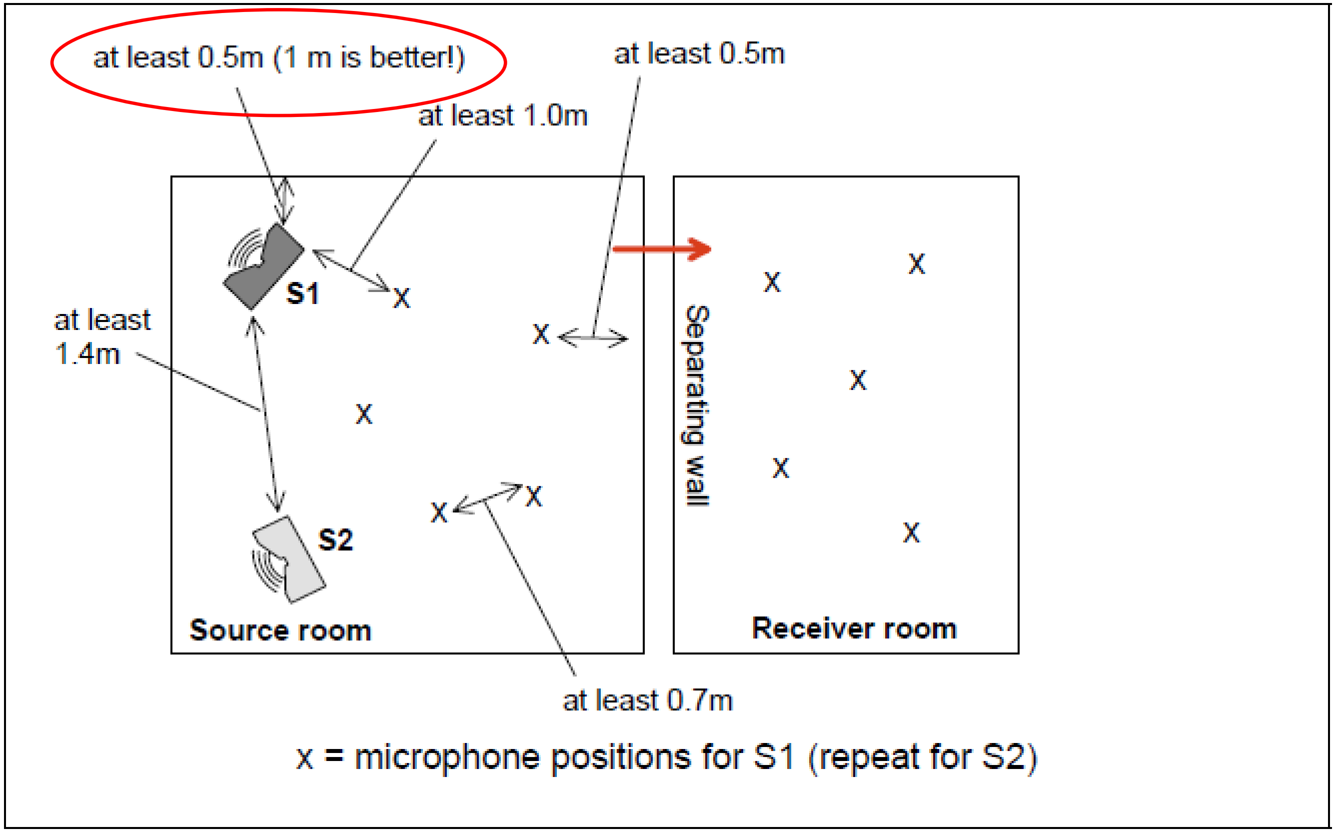
Therefore, to comply with this requirement of ISO 140-4:

"…at such a distance from the separating element and the flanking elements influencing the sound transmission that the direct radiation upon them is not dominant".

the sound source should be at least 1.2 metres from the separating element and any flanking element!

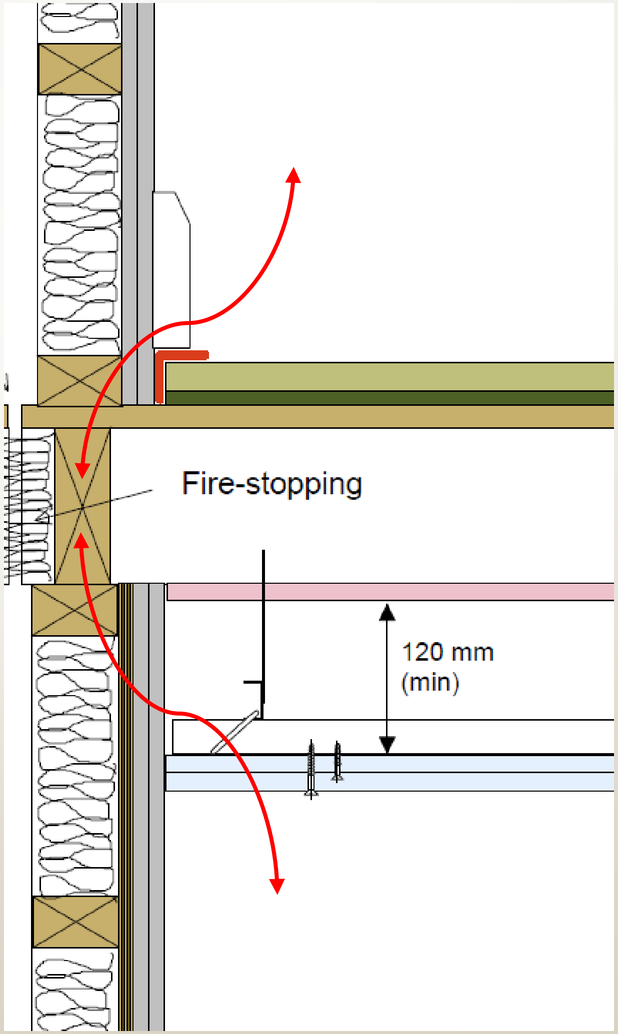
The PG assumes a critical distance of 1.0 metre, where practicable (so does ISO 16283-1).

Figure 1 - Typical separating wall test arrangement (plan view)



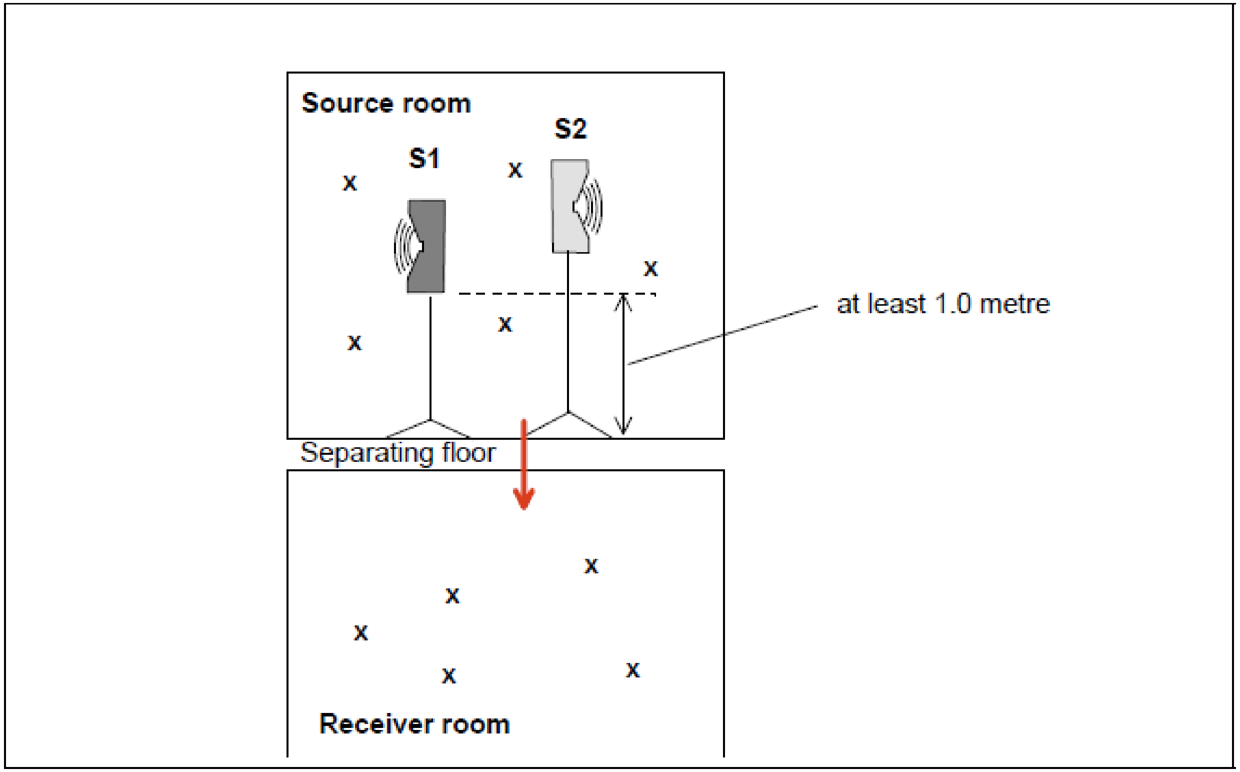
Floor tests (airborne)

- The 1.0 metre source to boundary distance is especially important for floor tests as vertically stacked rooms are always structurally coupled.
- Careless placement of sound source too close to flanking element can result in a 2 to 3 dB 'error'.



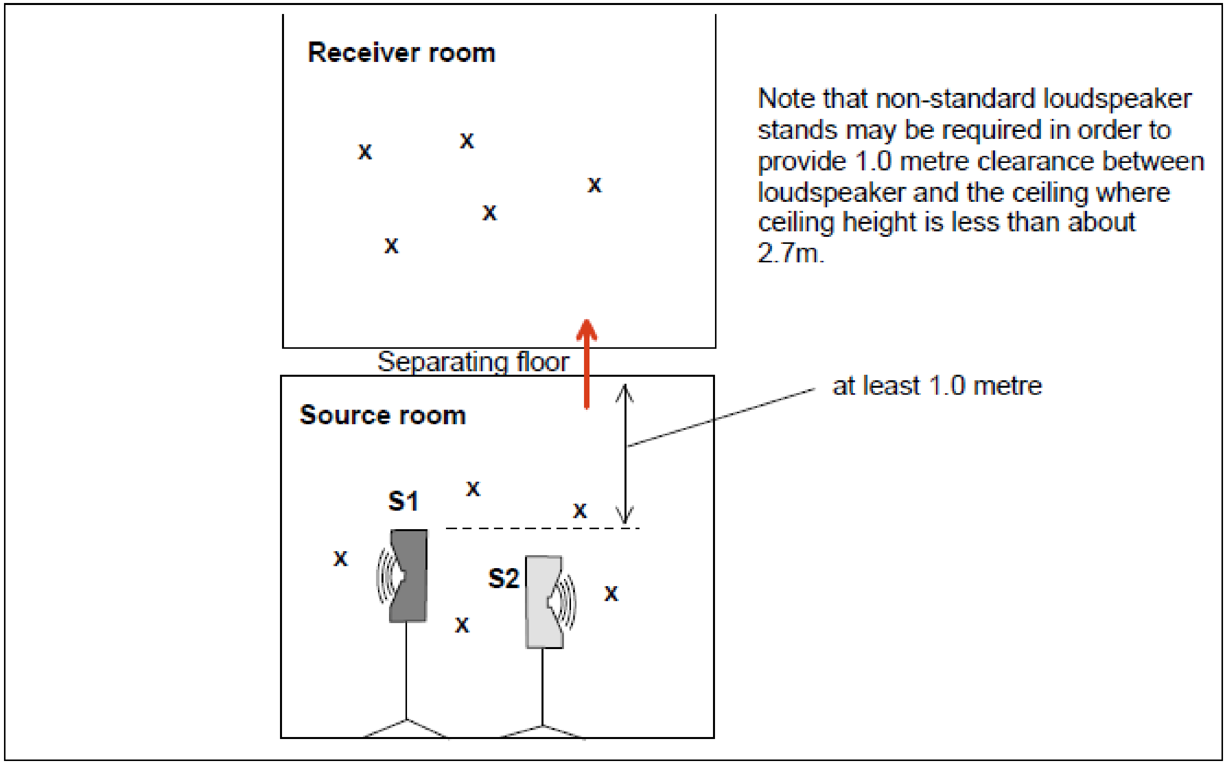
Section view noting minimum 1.0 metre source to boundary distance according to ISO 16283-1

Figure 5 - typical floor test arrangement (testing downwards)

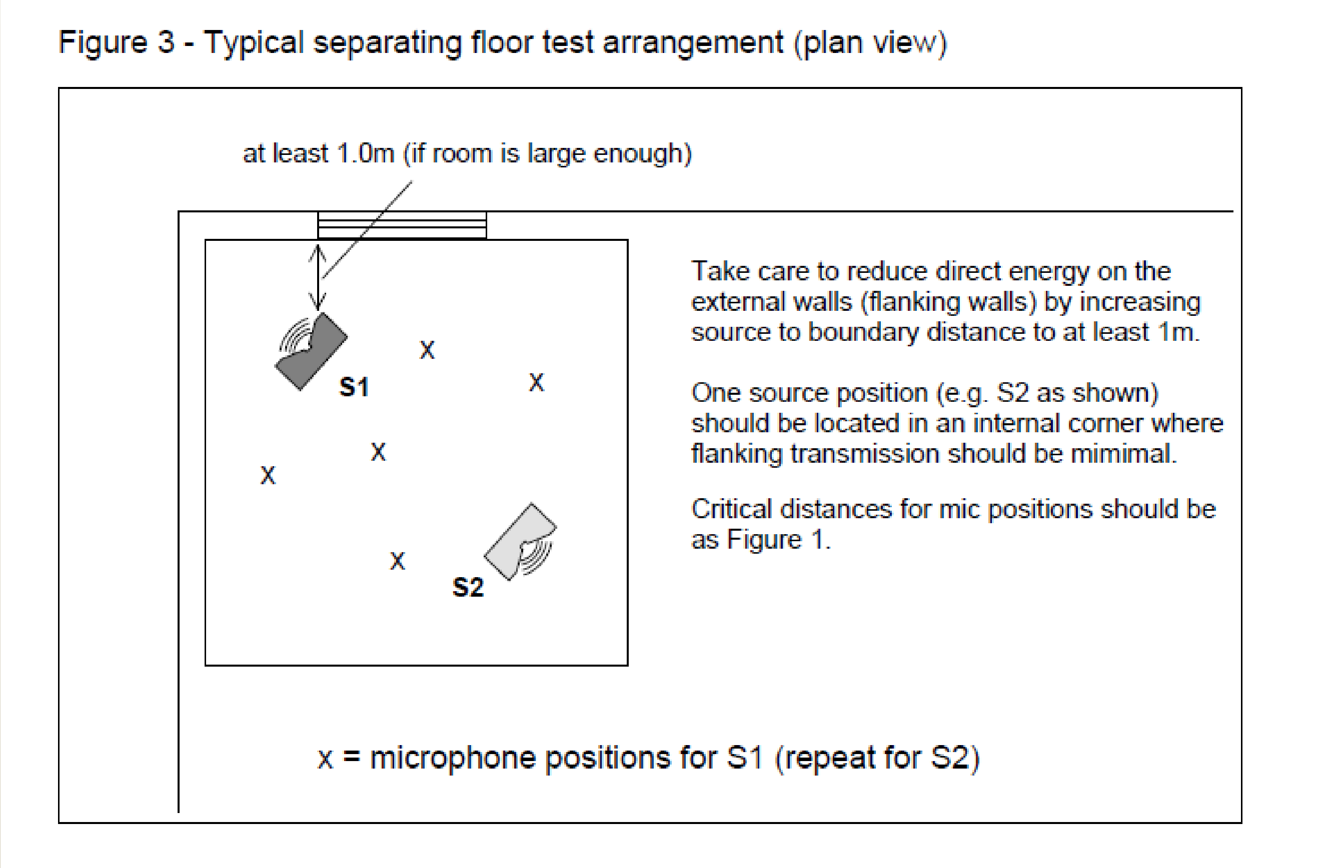


Same 1.0 metre rule applies when testing upwards

Figure 6 - typical floor test arrangement (testing upwards)

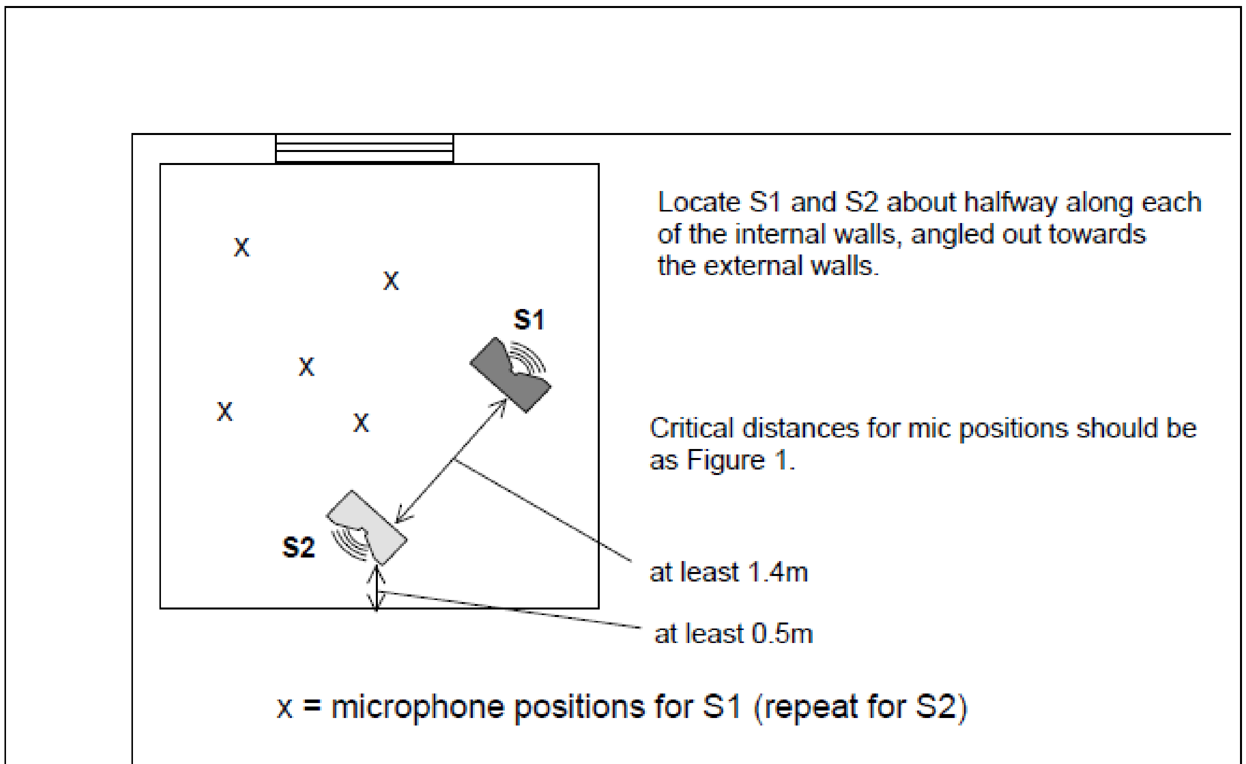


Separating floor test arrangement to minimise flanking.



Separating floor test arrangement to minimise flanking.

Figure 4 - alternative loudspeaker positions to reduce direct energy on external walls.

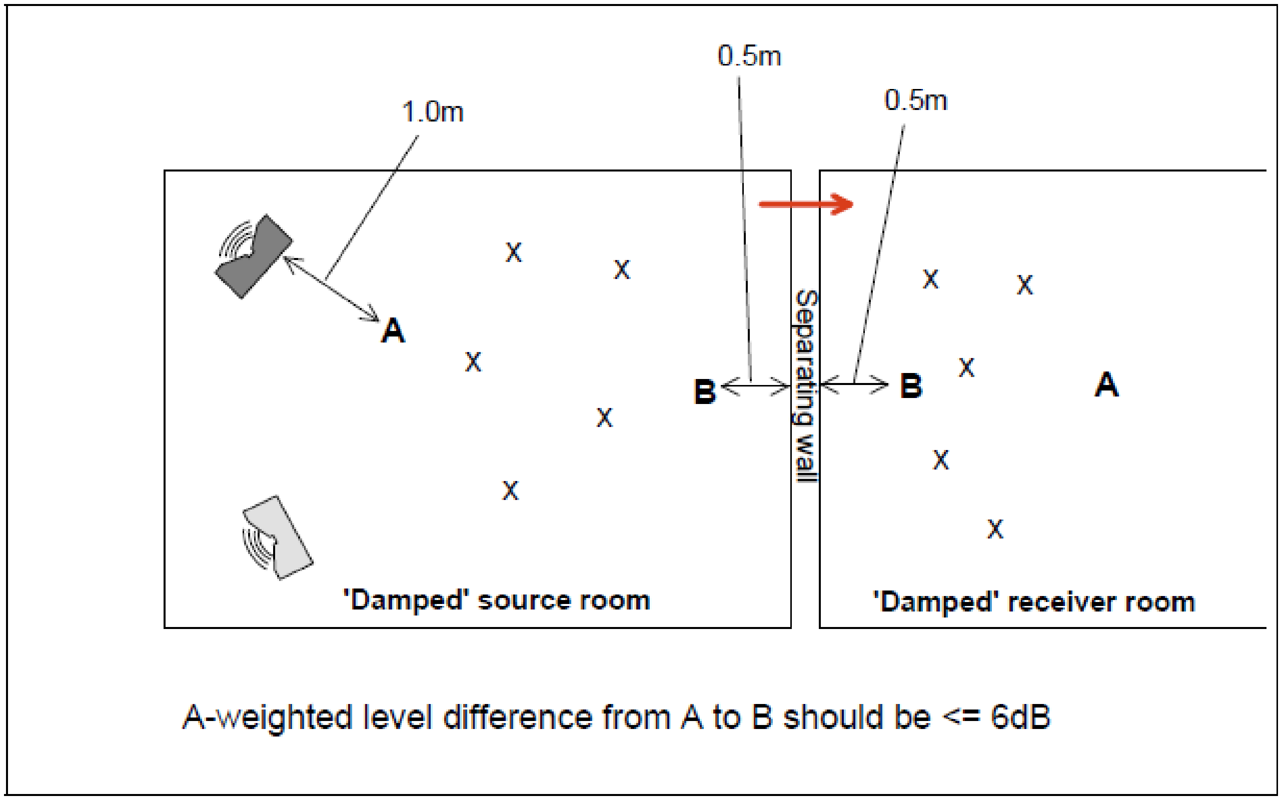


Damped (non-diffuse) rooms e.g. rooms which have carpet and/or soft furniture

- ISO 140-4 is intended for testing "under diffuse sound field conditions in both rooms" (Section 1 – Scope).
- ISO 16283-1 deals with damped rooms by a) specifying an omni-directional sound source and b) inclusion of a new procedure which tests for 'diffuse-field' conditions.
- For a cabinet loudspeaker in a 30 m^3 room with a 0.5 second RT, the critical distance is 1.8 metres. In a 50 m^3 furnished room, critical distance is 2.3 metres!

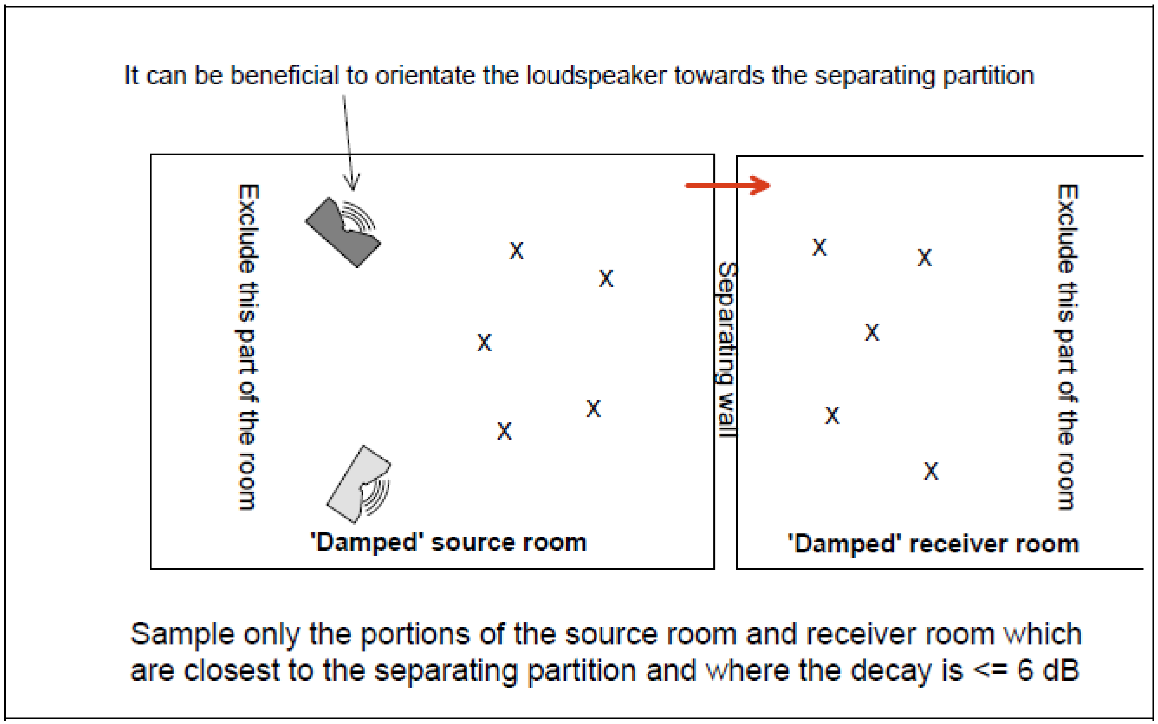
Testing large, damped (non-diffuse) rooms (The 'other' 6 dB rule!)

Figure 7 - check uniformity of sound field in damped source room.



Testing large, damped (non-diffuse) rooms

Figure 8 - moving loudspeaker closer to separating partition.

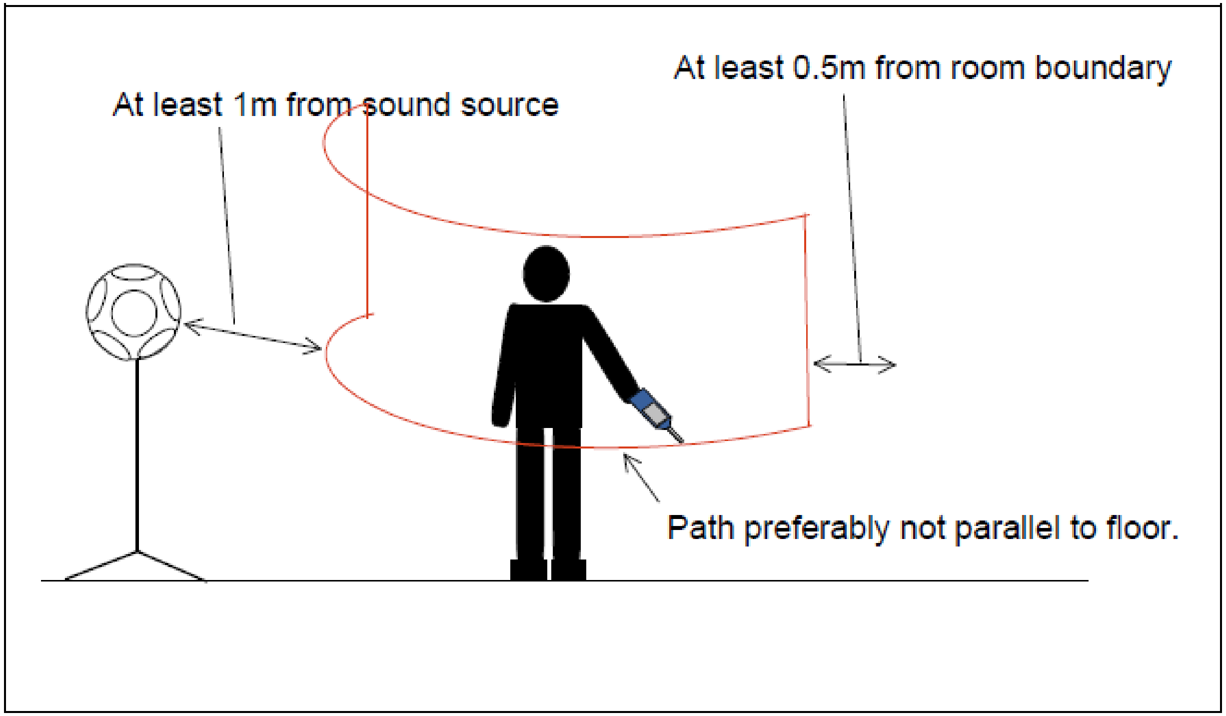


Careless sampling in damped test rooms can result in up to 6 dB 'error'.

2. Measure the sound field

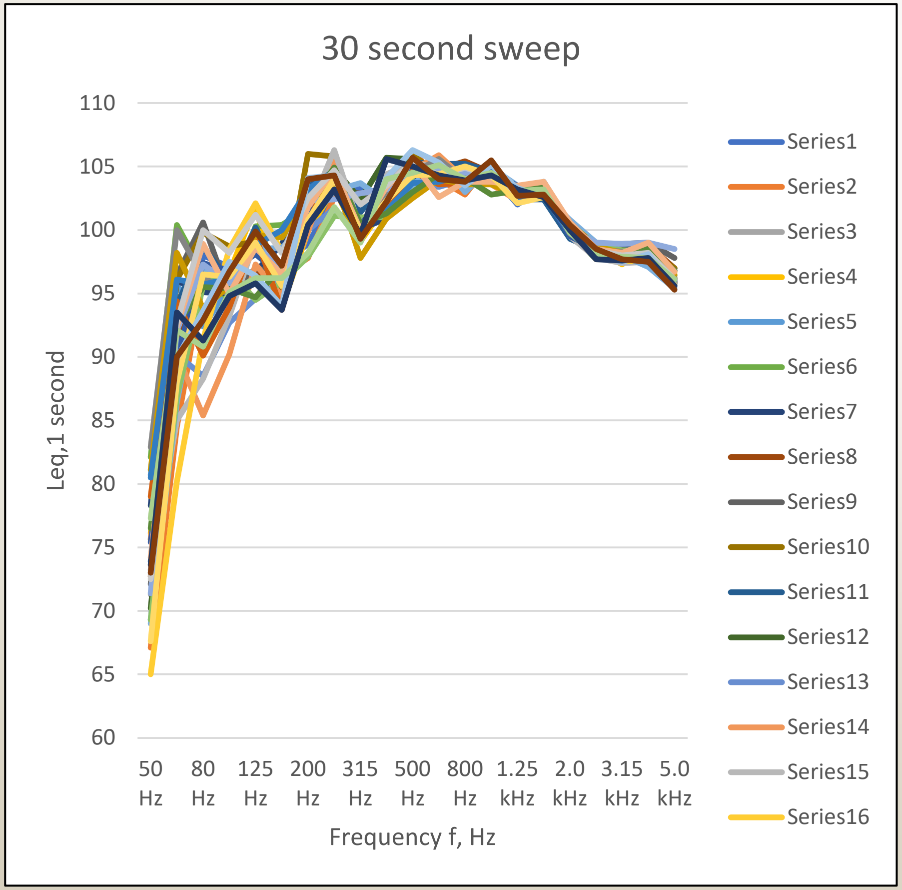
Fixed positions or manual, moving microphone?

Figure 23 - Cylindrical path



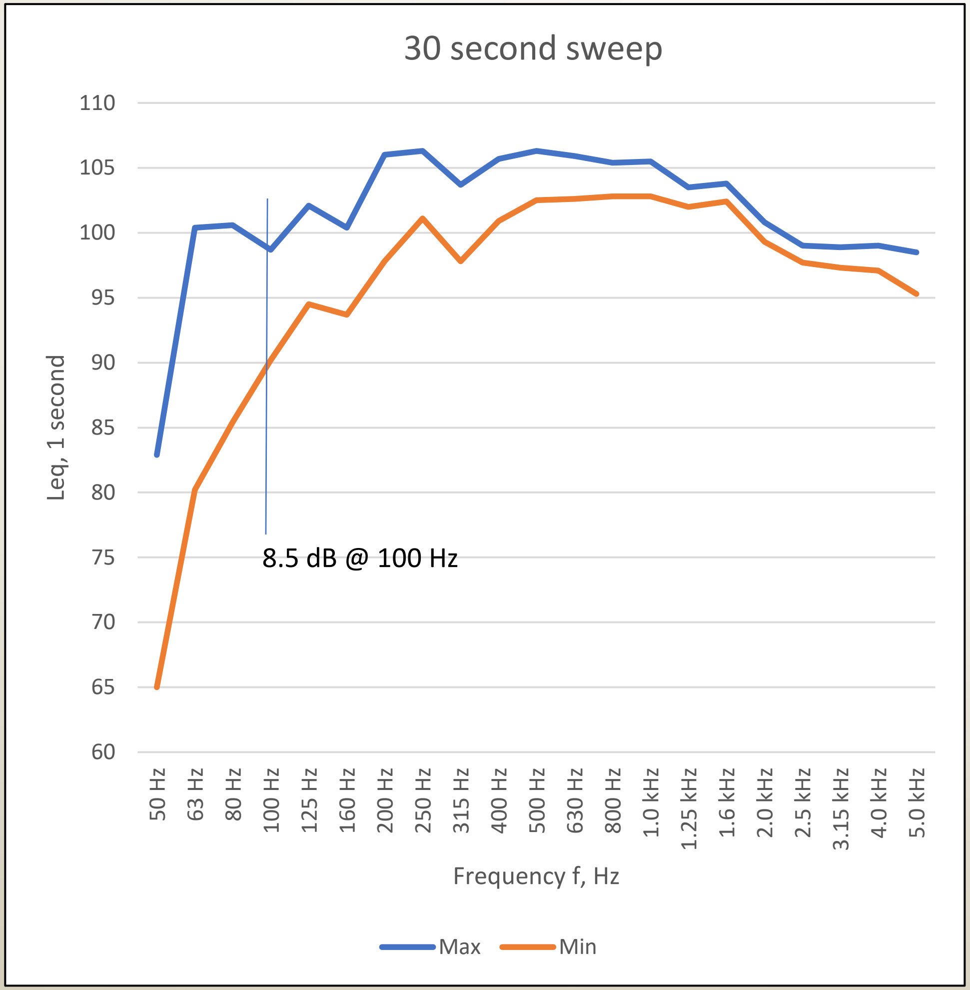
Using a manual sweep.

Typical source spectra in test room (masonry)



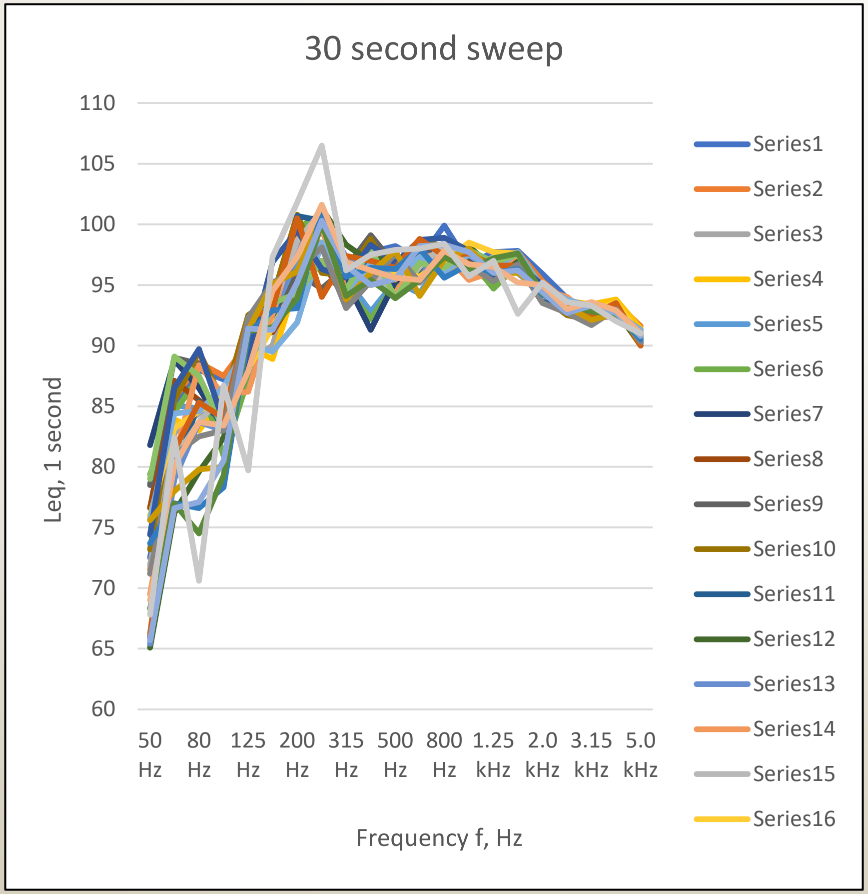
Room mode check.

Compare max and min
(up to 10 dB is normal and acceptable)

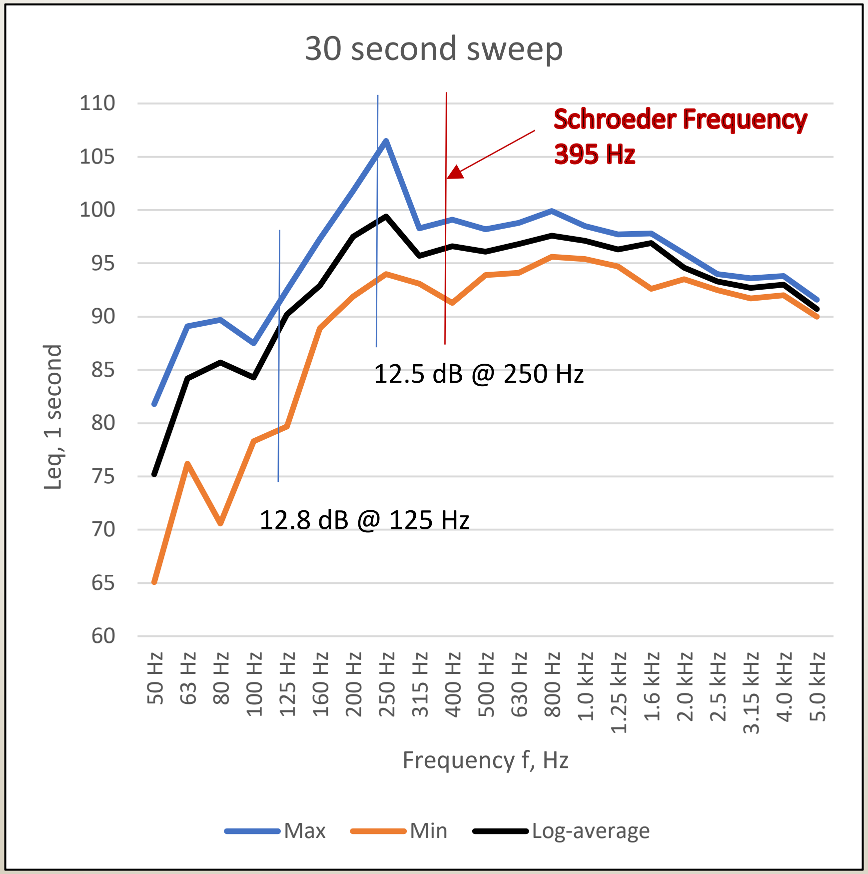


Timber framed building.

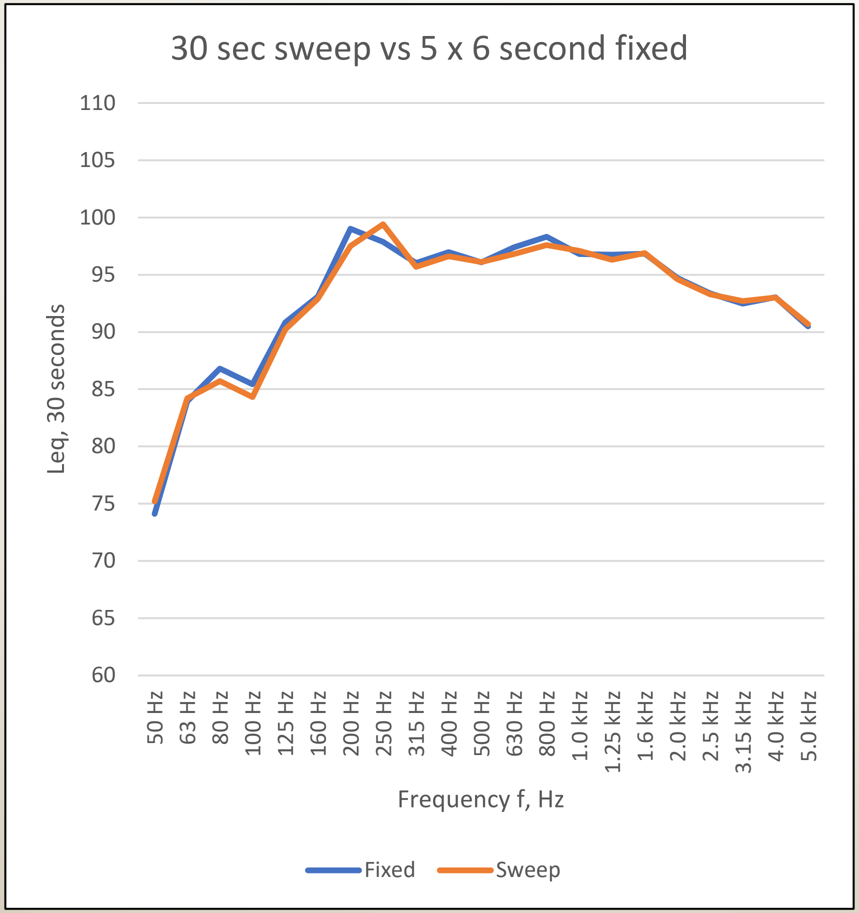
Evidence of room modes at 125 Hz and 250 Hz (max/min > 10 dB)



Evidence of room modes at 125 Hz and 250 Hz (max/min > 10 dB)



Using fixed microphone positions



Up to 1.5 dB sampling 'error'.

1 dB 'error' in test result!

Conclusions

- The PG describes model test procedures which comply with ADE and with ISO 140, while adopting many of the welcome changes in ISO 16283, as guidance.
- The aim of this presentation is not really to argue that one method is ‘better’ than another, but is to encourage testers to think carefully about the sound field in the room, its relationship to the test partition and the importance of source positioning.
- An understanding of the principles of room acoustics is essential to this process.
- With practice, this thought process will become intuitive.
- Careless and sloppy test procedures can result in significant measurement errors.
- Background noise and RT measurement also generate uncertainty but are dealt with, in detail, in the PG.

THANK YOU

Iain Critchley

Iain Critchley MIOA
Peninsular Acoustics Ltd
noise@btconnect.com