20 Hz, WHY……AND HOW?

The significance of impact sound measurement down to 20 Hz and how it is achieved.

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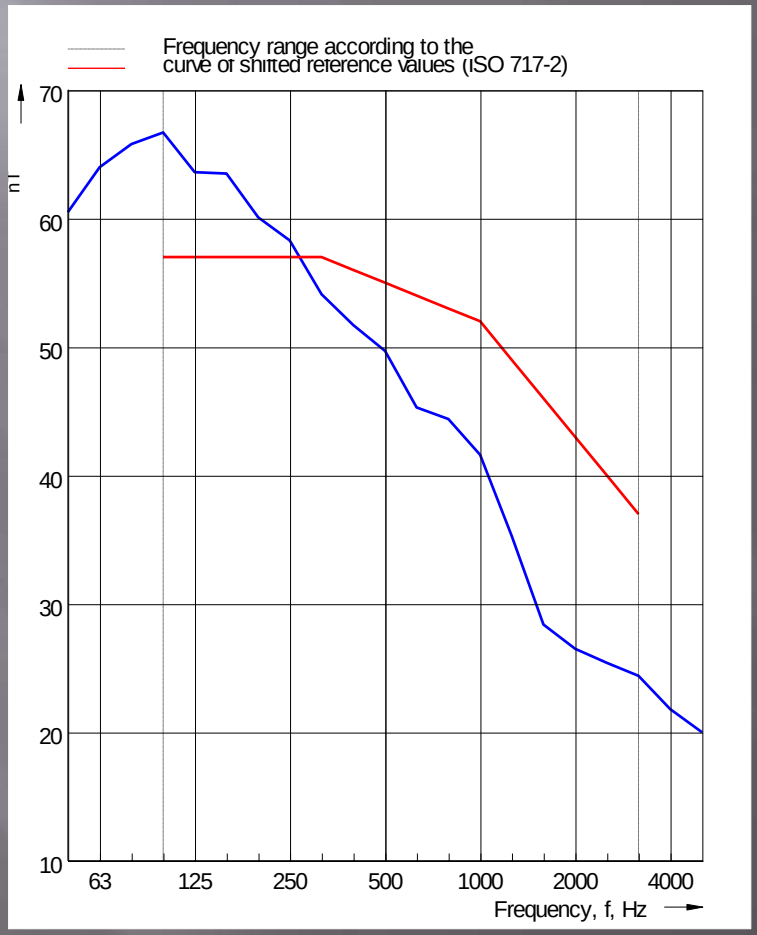
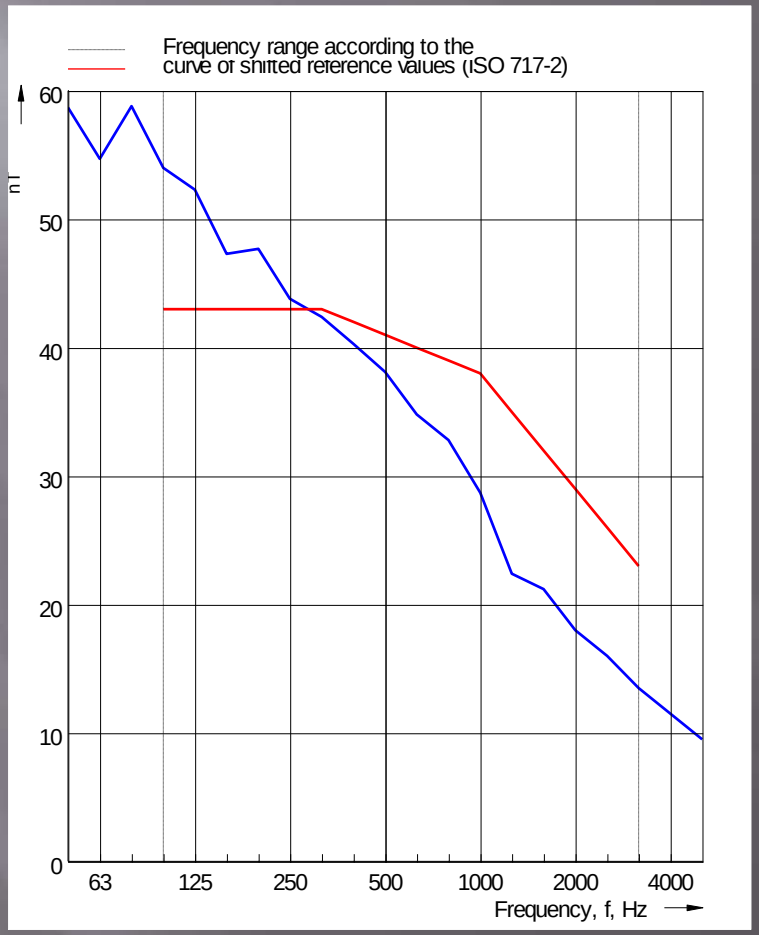
Timber and metal joist separating floors

- ADE does not require measurement of impact sound below 100 Hz, yet footfall noise in lightweight separating floors, a very common cause of 'Neighbour Noise Annoyance', is normally at frequencies below 50 Hz.
- Why do we continue to ignore this important fact?
- Let's examine some sample test results…..

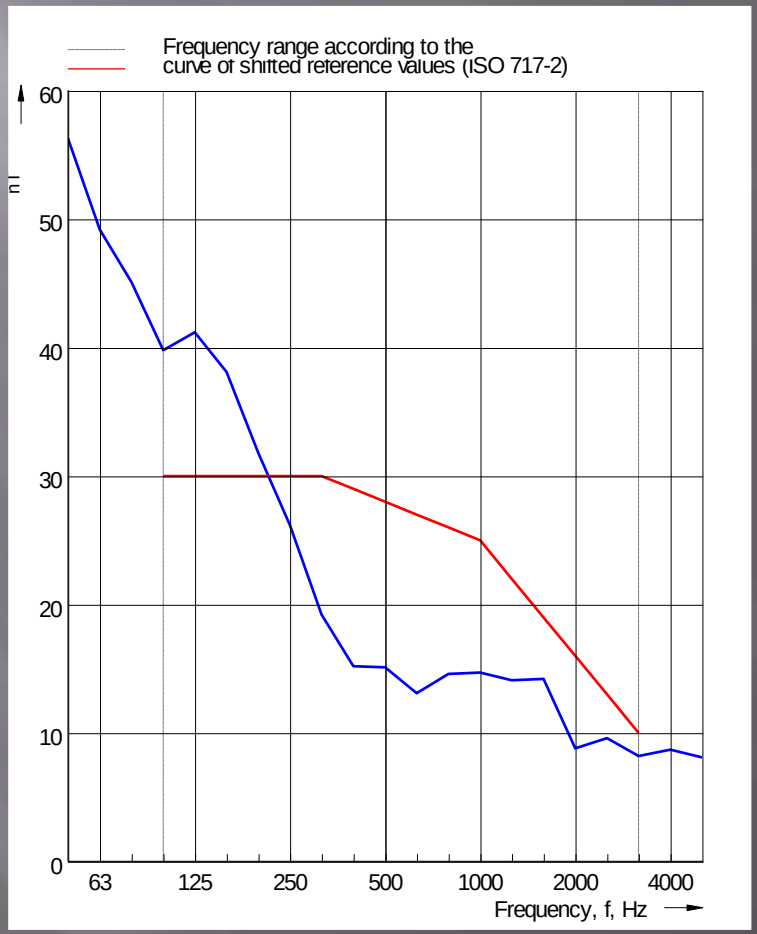
55 dB $L'_{nT,w}$ (Solid wood)

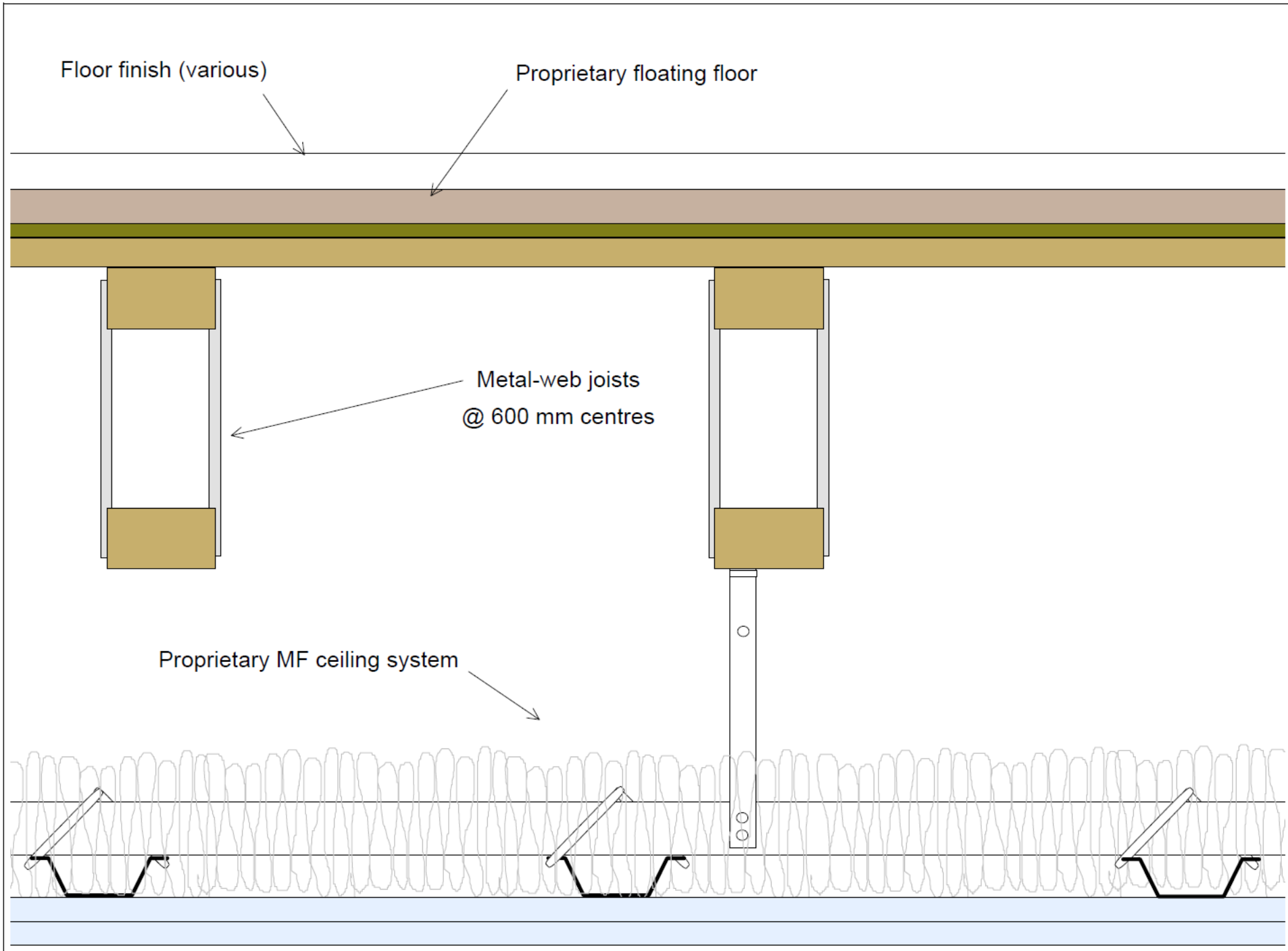


41 dB $L'_{nT,w}$ (Marble tiles)



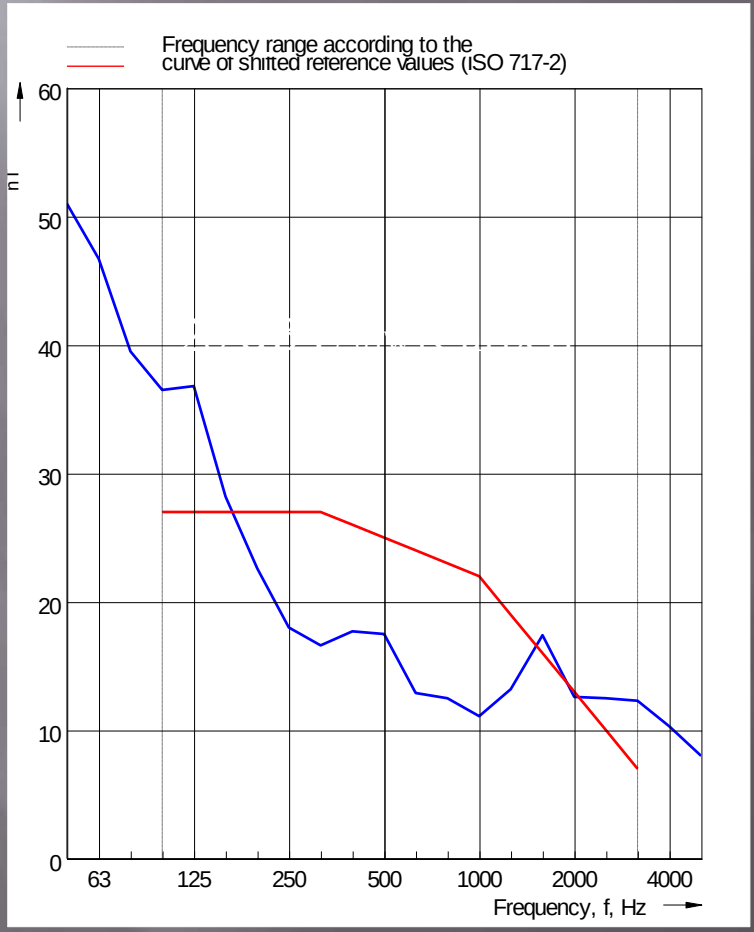
28 dB $L'_{nT,w}$ (Carpet)



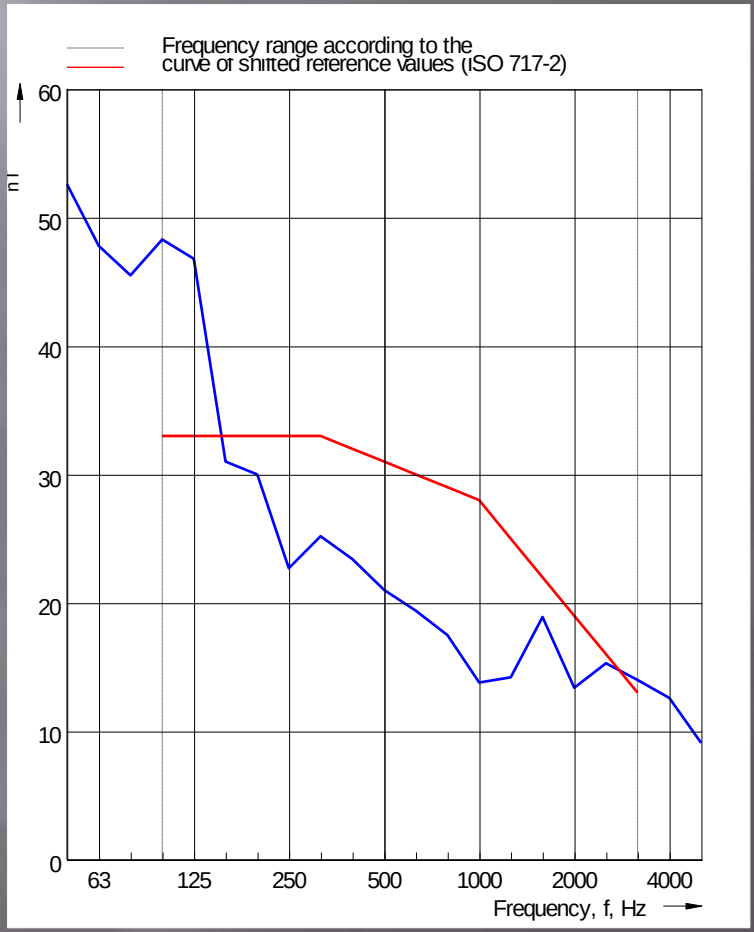

Floor finish (various)
Proprietary floating floor
Metal-web joists
@ 600 mm centres
Proprietary MF ceiling system

- As you would expect, the rooms relating to these tests were described, subjectively, by the occupant of the apartment as either “good”, or “not bad”, in terms of annoyance caused by footfall noise.
- But what about these……?

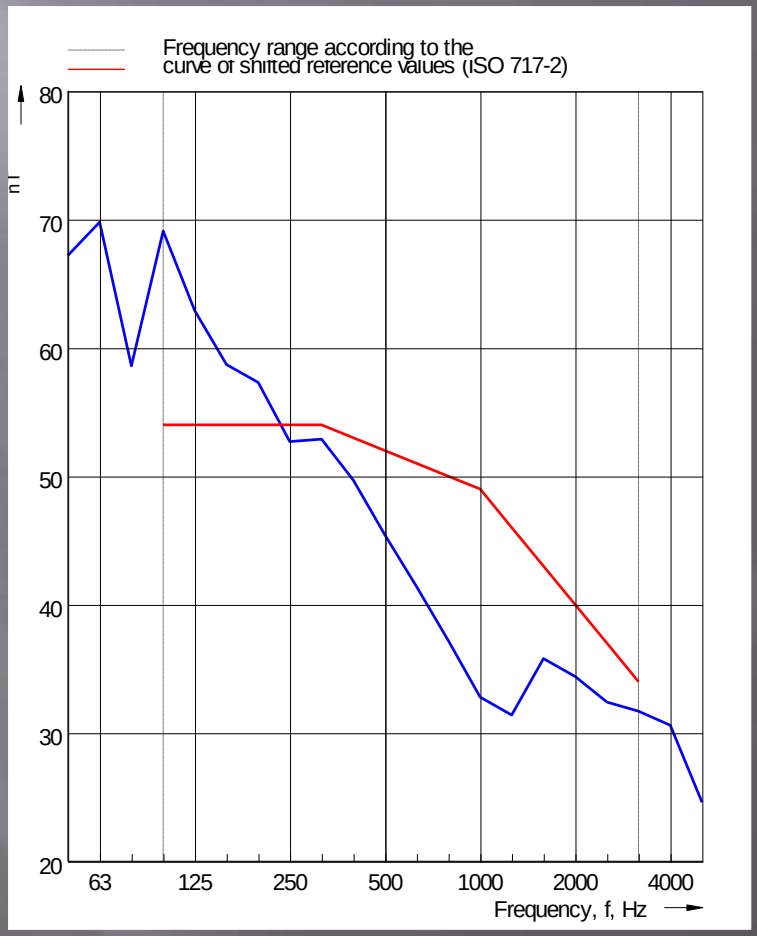
25 dB $L'_{nT,w}$ (Carpet)



31 dB $L'_{nT,w}$ (Carpet)



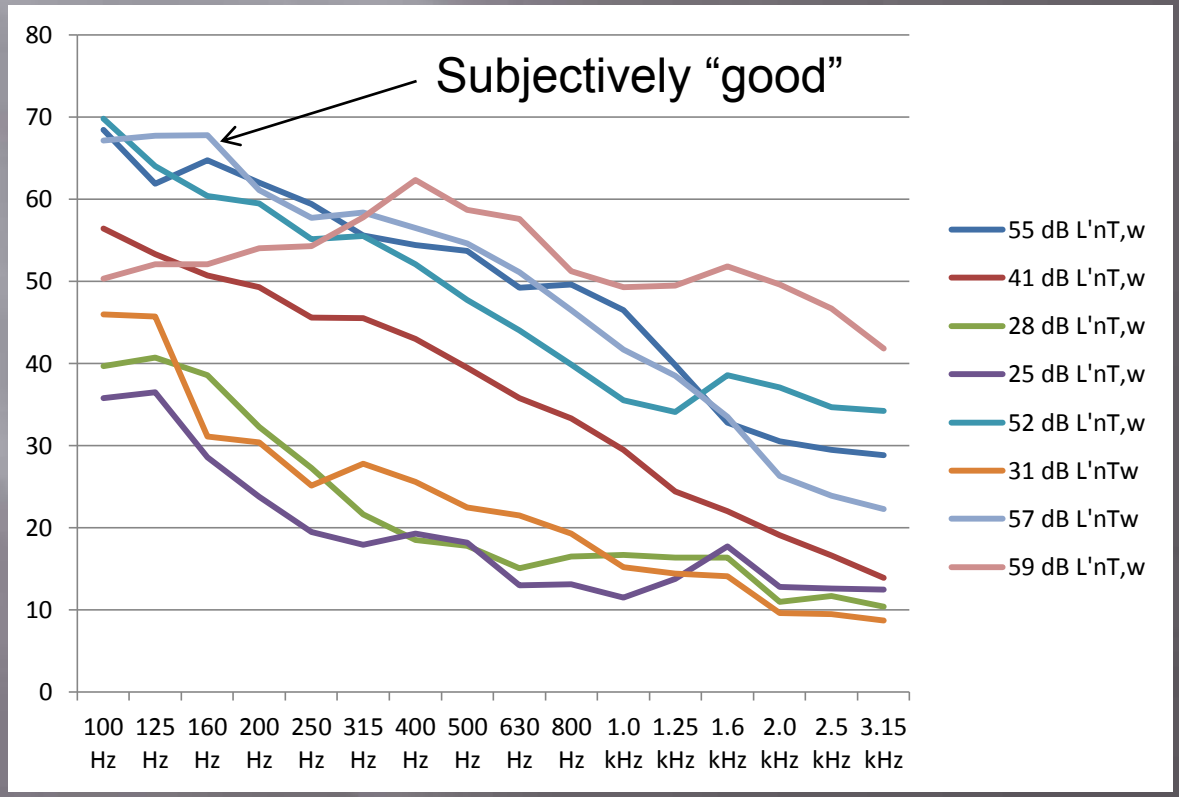
52 dB $L'_{nT,w}$ (Hard vinyl)



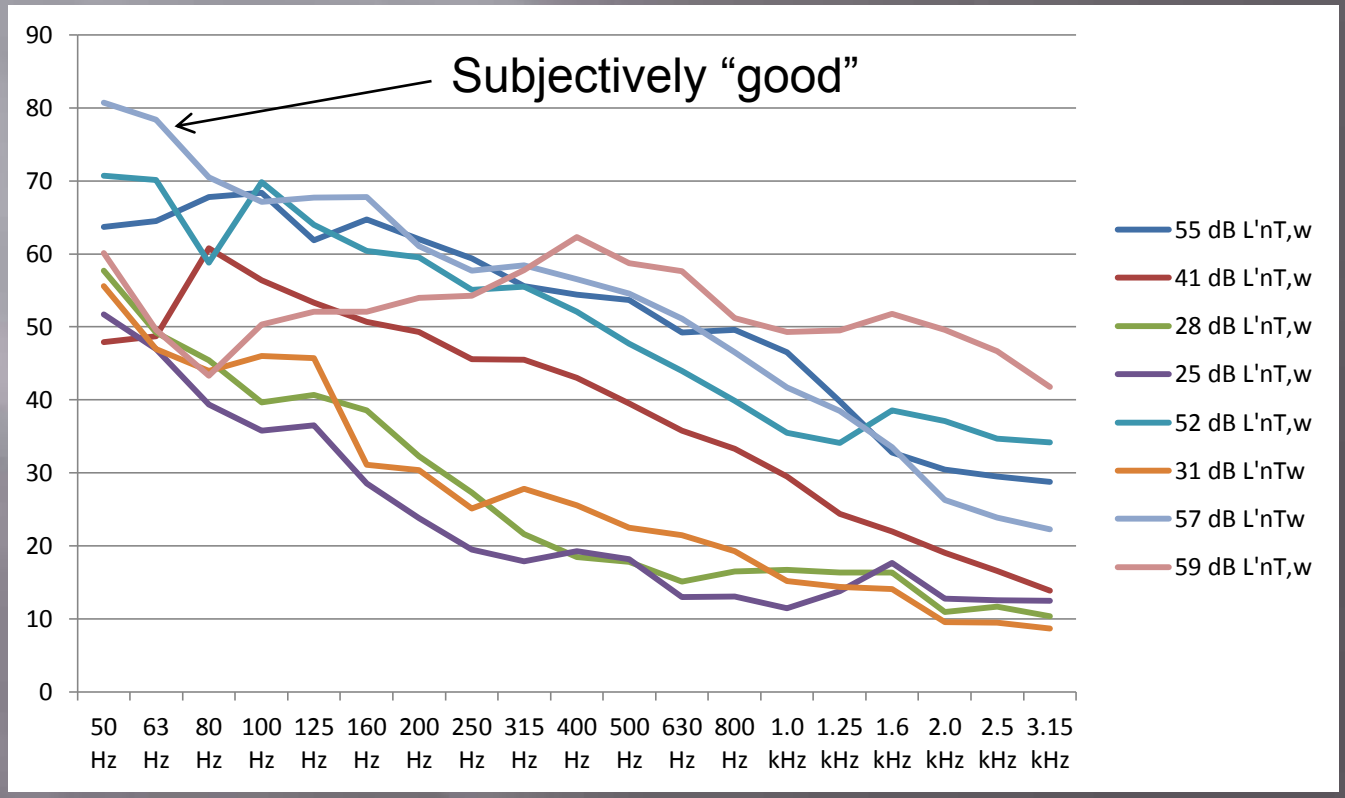
- Those test results are, on the face of it, quite good and are a ‘pass’ under ADE, and even a ‘pass’ according to the more stringent ‘Scottish Regs’.
- As an acoustic consultant and ‘designer’ I would be happy, on the basis of those tests, to describe those floors as ‘good’.
- Yet these three rooms were described by the occupant as either “very bad” or “intolerble”.

So what is going on?

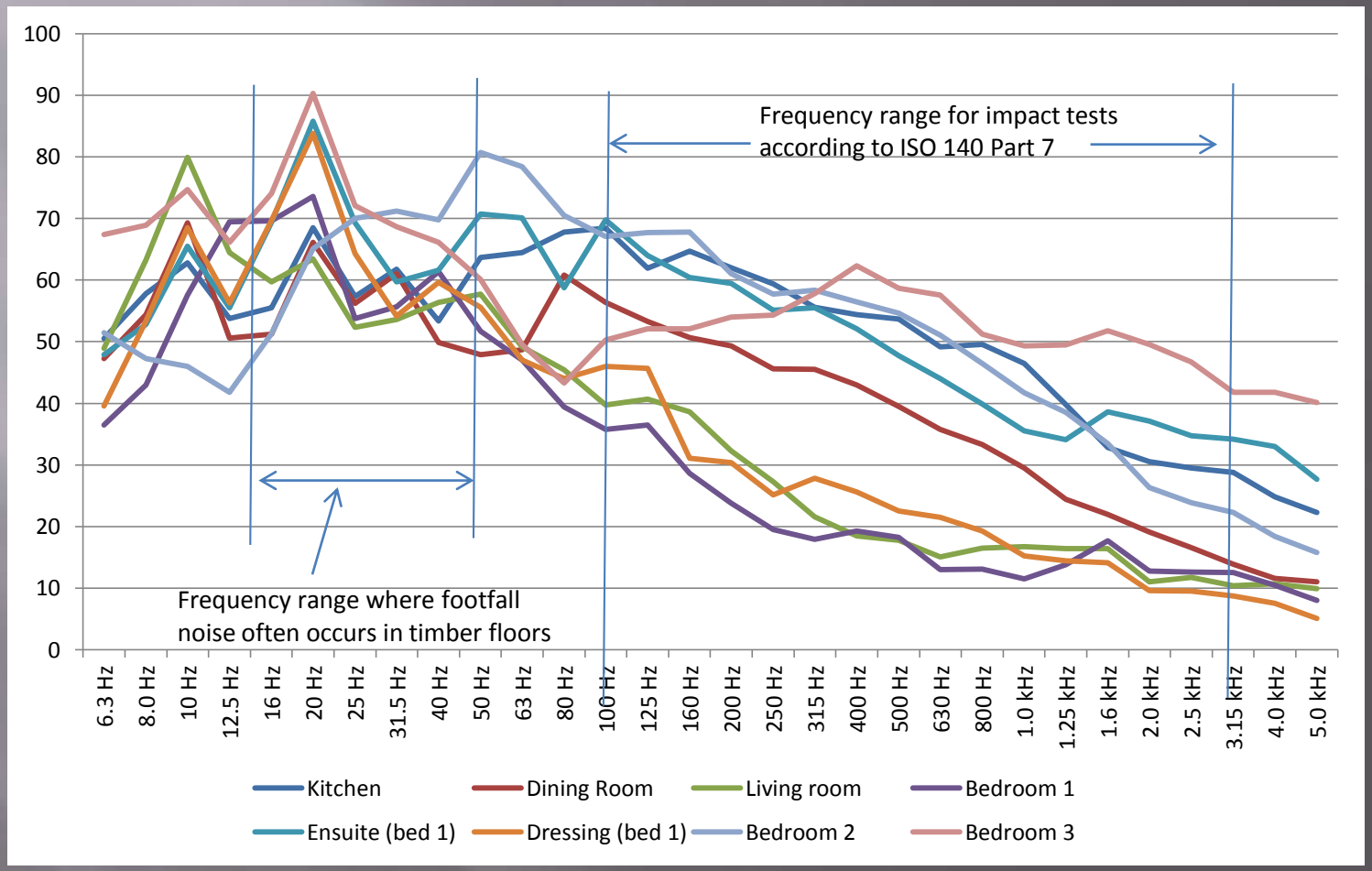
- Measuring from 100 Hz tells us nothing!



- Neither does measuring from 50 Hz!



Extending frequency range to below 20 Hz

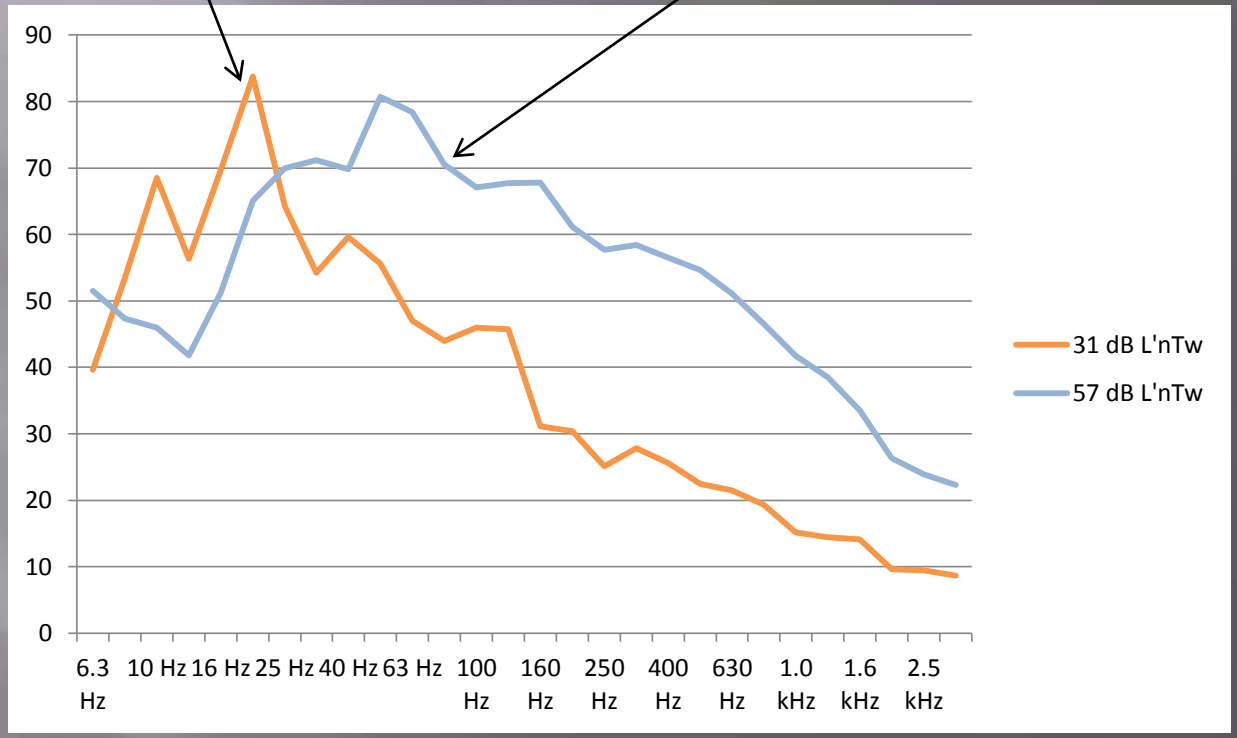


Subjective annoyance rating correlates well with 20 Hz third octave band.

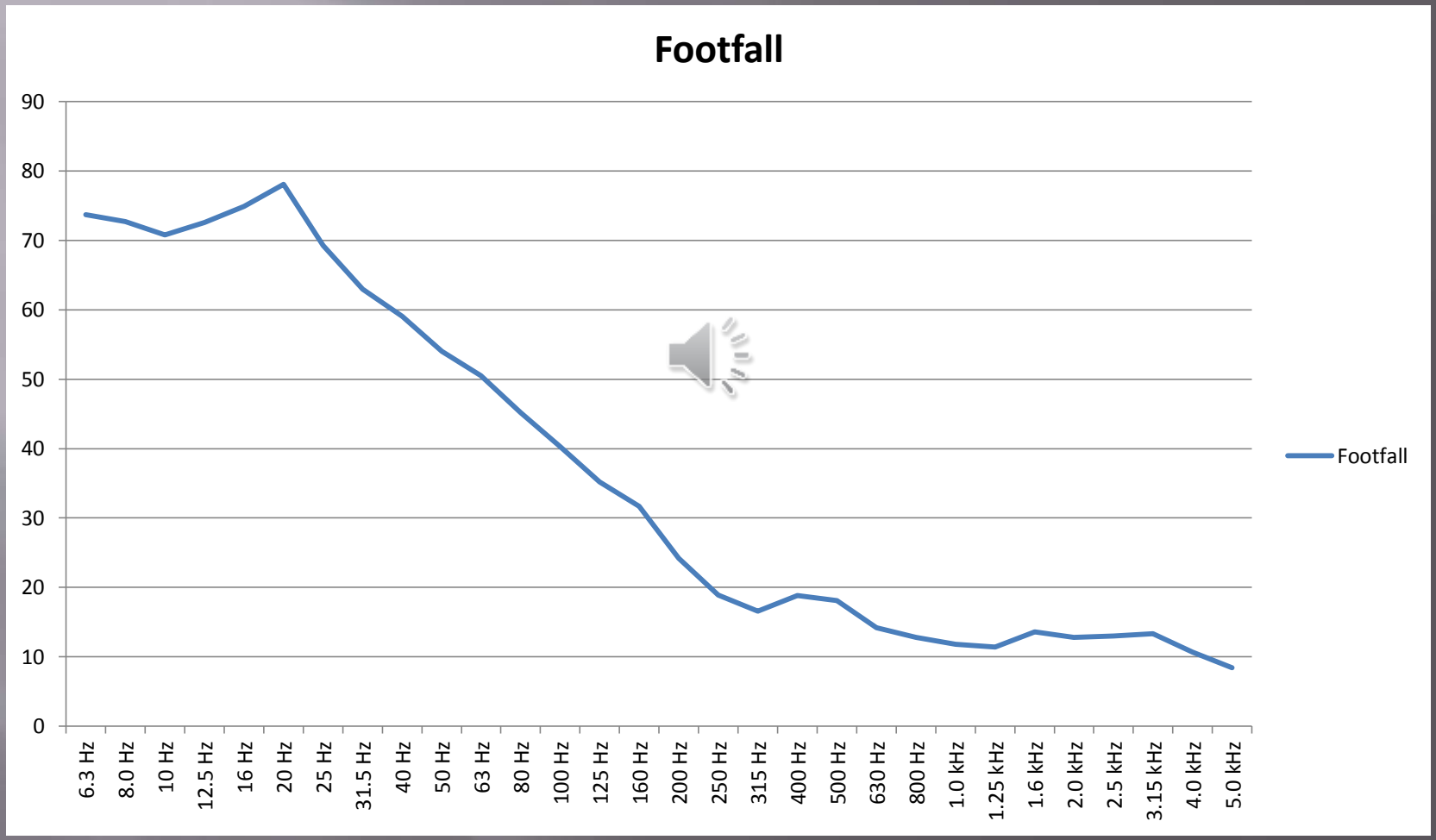
Room	Floor finish Flat above	LnTw	LnTw+Ci(50-2500)	Ln(20Hz)	Subjective response
Living room	Carpet	28	43	63.4	Not bad
Bedroom 2 (used as study)	Solid oak	57	68	65.1	Good
Dining room	Marbe tile	41	49	66.1	Good
Kitchen	Solid Oak	55	58	68.5	Not bad
Bedroom 1	Carpet + new suspended ceiling.	25	38	73.6	Poor
Dressing room	Carpet	31	41	83.8	Very bad
Ensuite	Hard vinyl	52	59	85.8	Intolerable
Bedroom 3	Carpet	59	55	90.3	Intolerable

Subjectively “very bad”

Subjectively “good”



Measured footfall noise



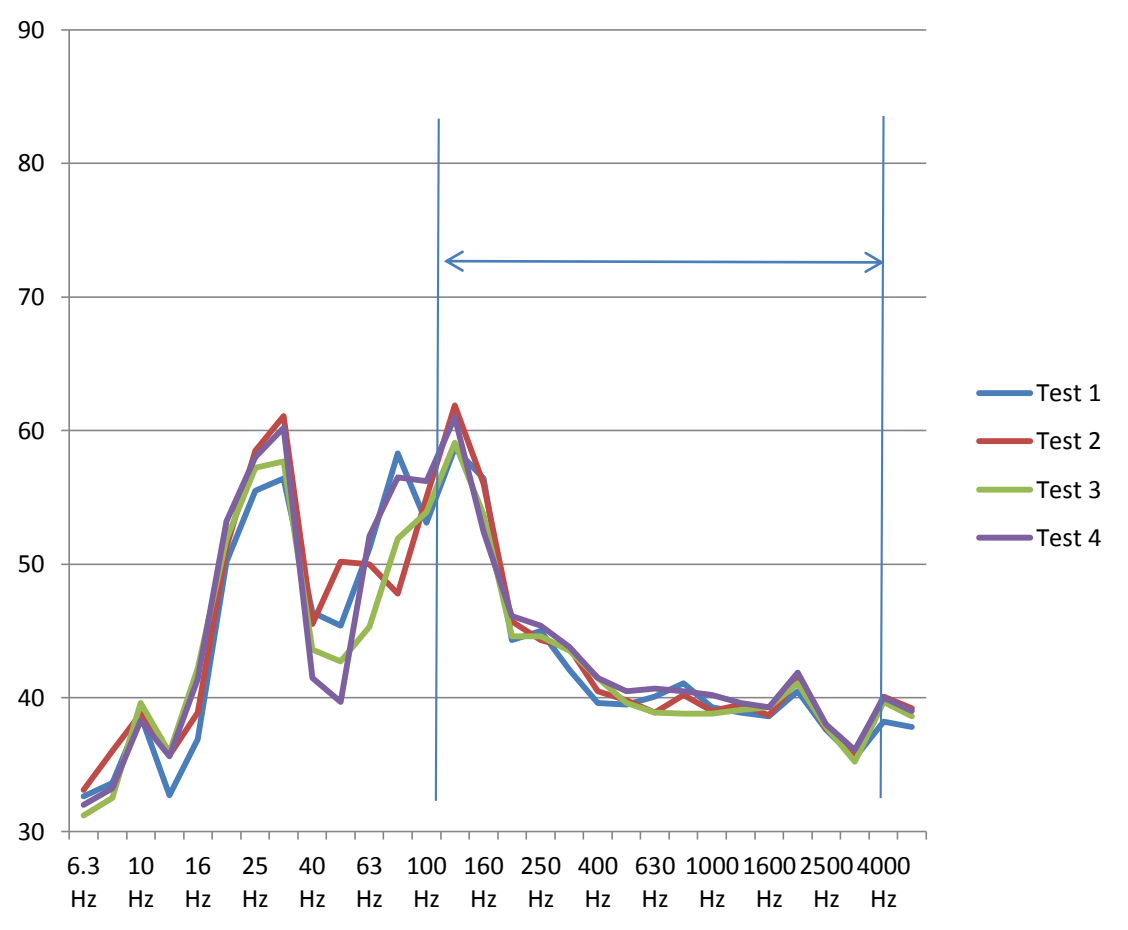
Tapping machine on same floor (55 dB L'nT,w)

Suggested Criteria?

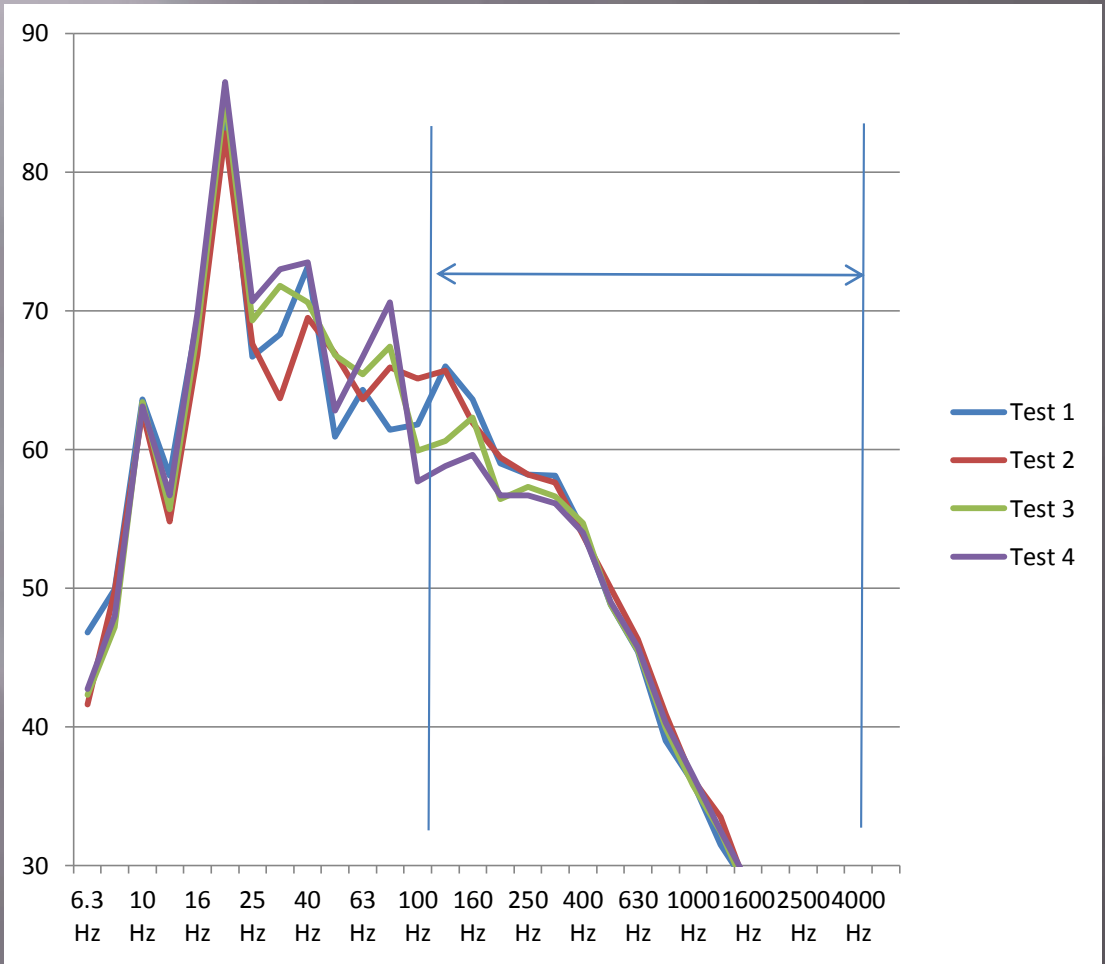
- Dose/response analysis of about 70 tests carried out for housing association clients suggests that most occupants are “not annoyed” when the 20 Hz third octave band level is below about 70 dB.
- This applies only to timber-joist (and metal-joist) separating floors.
- Concrete floors are generally less than 60 dB at 20 Hz so generate fewer footfall noise issues.

Some more examples

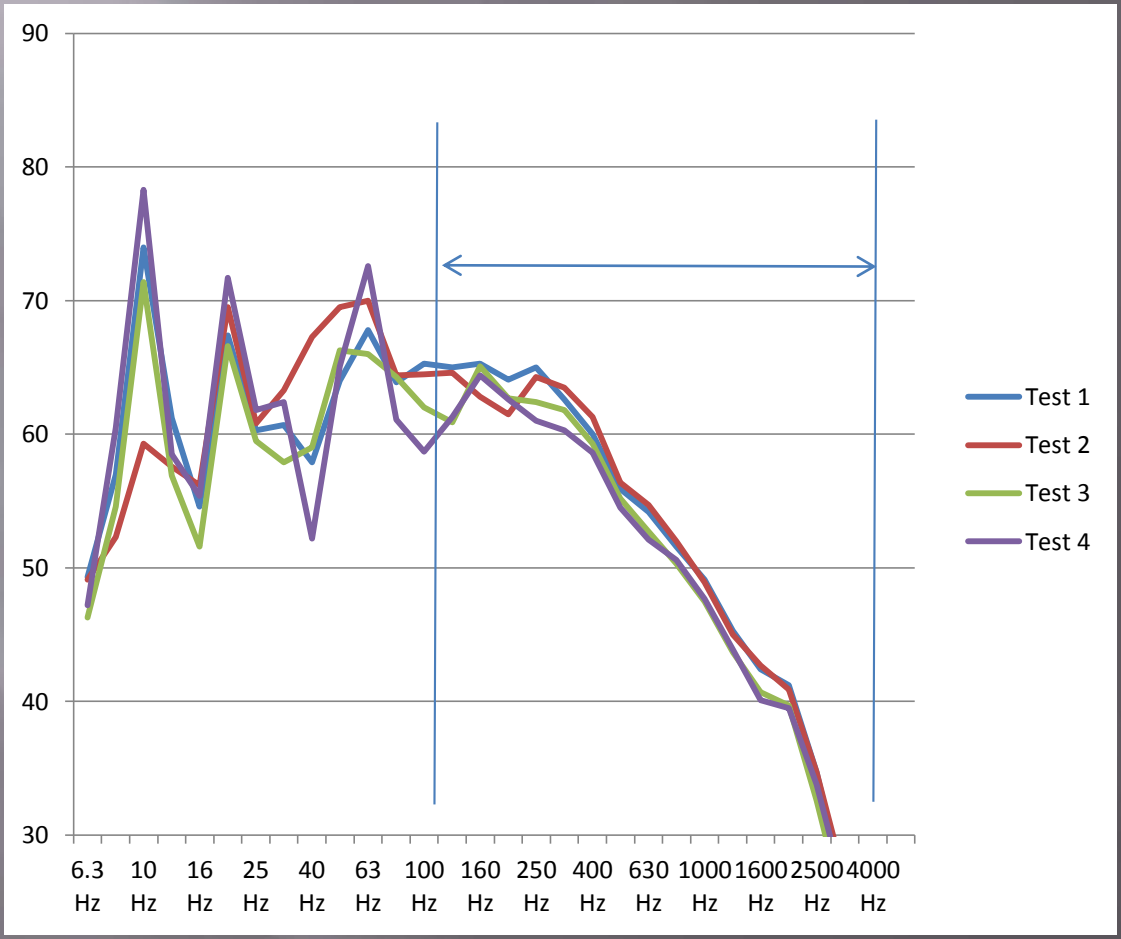
Typical Concrete floor.



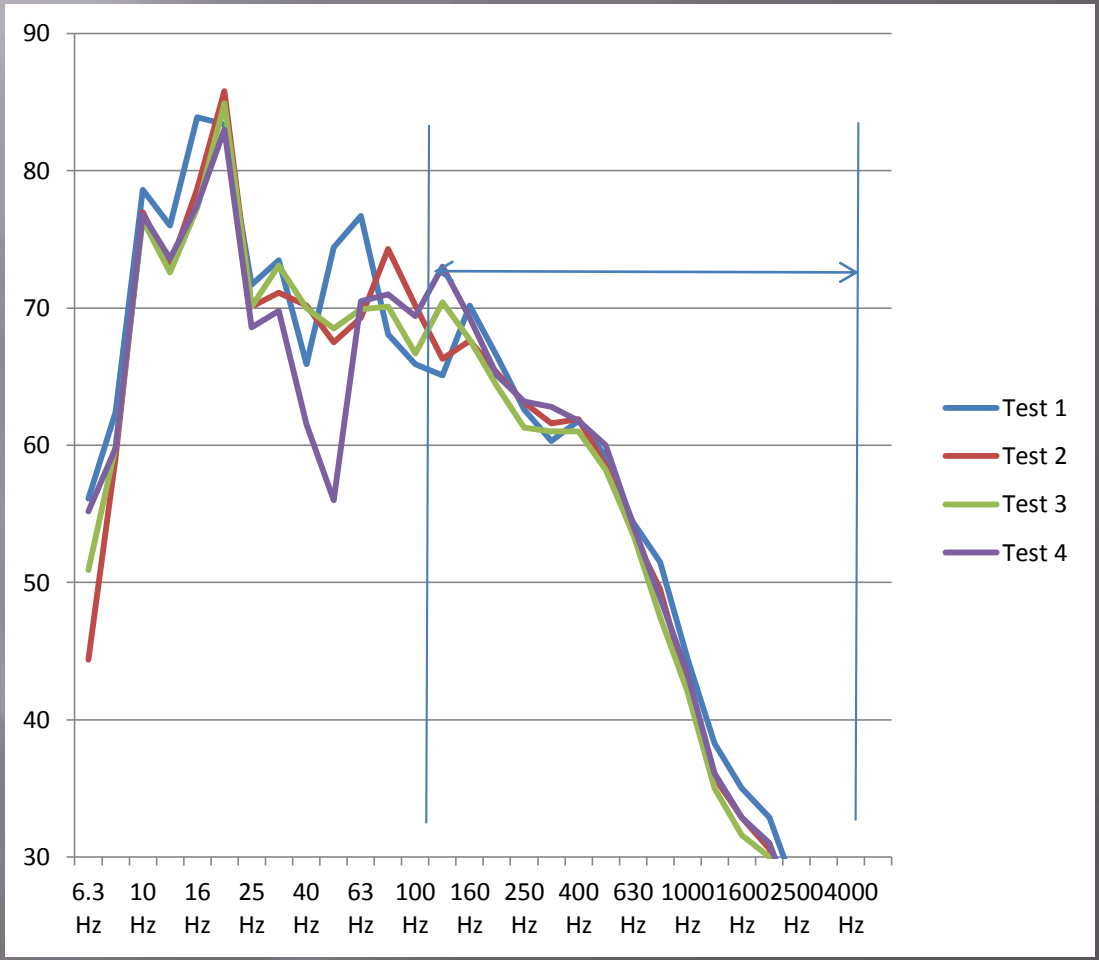
Typical timber floor.



Timber floor with secondary ceiling.



Steel joist floor.



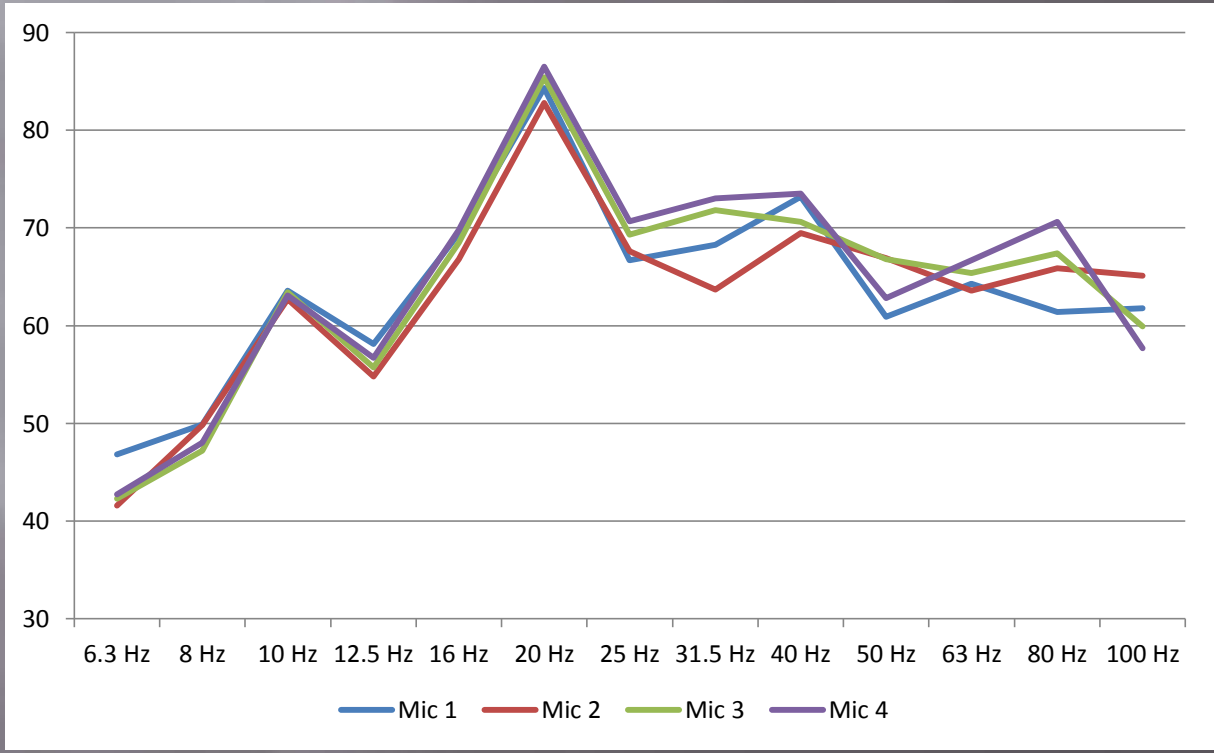
How to measure at 20 Hz (and dispel the myths)

But we can't measure at low frequencies can we?

- It is true that there is greater measurement uncertainty below about 100 Hz in small rooms but, at *very* low frequencies, there are no room modes so we are just measuring changes in 'pressure'.
- For impact measurements, the tapper generates a lot of energy at 10 Hz (100 ms between hammer drops) with harmonics at 20 Hz and 30 Hz. This causes the floor to respond in a similar way to normal footfall excitation.
- Below 100 Hz it is sufficient to measure just the sound pressure level without RT correction.

Repeatability of measurement

(One tapper position, four separate mic positions)

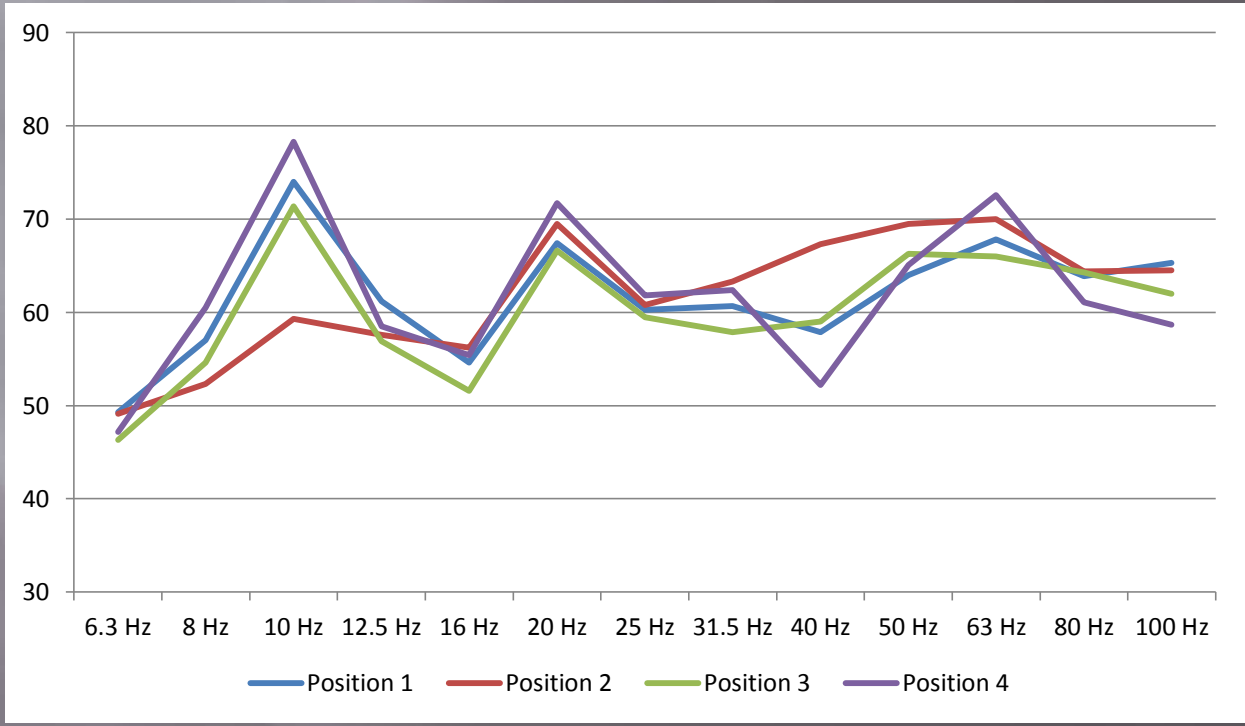


SD @ 20 Hz = 1.37 dB

SD @ 100 Hz = 2.72 dB

Repeatability of excitation

(One mic position, four separate tapper positions)



SD @ 20 Hz = 1.98 dB

SD @ 100 Hz = 2.57 dB

Conclusions

- We must find a better way to measure impact sound in lightweight floors which better correlates with ‘annoyance’ due to footfall noise.
- Limiting the frequency range to 100 Hz is useless!
- Evidence shows that measurements in the 20 Hz third octave band give very good correlation with ‘annoyance’.
- Measurement of impact sound at 20 Hz is very easy and repeatable, using a standard tapping machine.
- Any future measurement parameter or weighting network should take into account impact sound at 20 Hz.
- Consequently, the construction industry should improve the design of lightweight floors (but that is the subject of a further discussion!).