AcoustiGuard®

Acoustics 101 – Part 1

Soundproofing

The very word is a ticking time bomb of misplaced expectations. To soundproof a room is a colossal and complex undertaking, which will produce a similar sized expenditure.

Soundproof rooms ONLY exist in the very best of recording studios, and in industrial applications like anechoic chambers, or in outer space where there is no air.

Sound-transmission mitigation – now this is a realistic and possible goal for most clients! To what extent? For how much money? How much physical area will be required to achieve the mitigation?

These are the realistic questions that must be asked, answered and budgeted for before construction begins.

Air in, Air out

Would you like to be able to breathe in the room or apartment?

If air can move freely between adjacent rooms or spaces or apartments – so can sound. How do you propose to reduce the transmission of sound between and within the shared ductwork (installed throughout the space/building) of your heating and air-conditioning system?

Will each room/apartment have its own air-handling system? If not, how can the sound that will be in the ducts be mitigated?

Flanking Paths

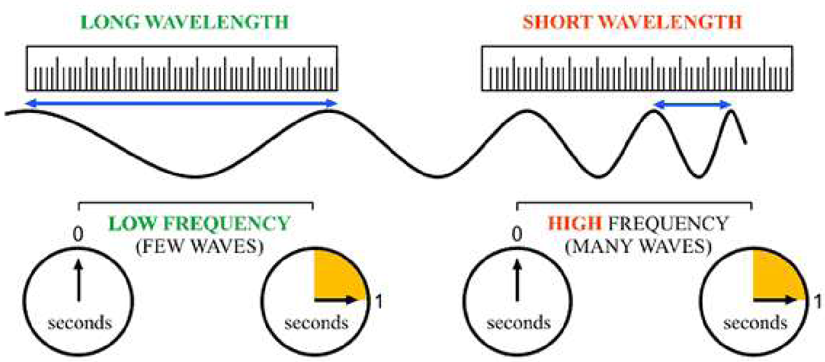
An old adage of the acoustics industry is *"... if a 1/4-inch gap is left open below a door, 60% of the sound produced in the room will escape..."*

Sound is sneaky...! It will attempt to escape from any room, by any means (paths) possible. Sealing all flanking paths (gaps, penetrations, door jambs, etc...) is a small but important detail.

In older wood-frame buildings (typically single-family homes) the flanking paths are so numerous that there is typically only a limited amount of isolation performance that can be achieved. Considering that all the walls and floors are nailed/screwed? Together, the entire house (from roof to basement) must be thought of as one big block. With all parts connected to all other parts. If sound vibrations are allowed to enter the walls and floors, those same sound vibrations will travel within the structure and possibly reappear somewhere else in the home. Stopping vibrations from entering structure is key.

Physics Review

The physical characteristics of frequencies are varied. High frequencies are very short in wavelength and have a small amount of power. Whereas, low frequencies are very long in wavelength and have a large amount of power.



Human hearing has the ability to hear all frequencies between 20 Hz. & 20,000 Hz. (approximately 9-1/4 octaves) – a very large range.

Below is a table with example frequencies in the low, mid, and high ranges showing the wavelength of notes. The wavelength of a sound or portions of a sound is crucial information to know or calculate. With the wavelength dimension known, absorbers can be designed to absorb effectively at different frequencies.

Low – (Approx. 20 Hz. to 250 Hz.)

20 Hz	= note E flat	octave -1	limit of human hearing	wavelength 56-feet
27.5 Hz	= note A	octave 1	lowest piano note	wavelength 41-feet
41 Hz	= note E	octave 1	open E on bass guitar	wavelength 27-feet
123 Hz	= note B	octave 2	2nd harmonic ground hum	wavelength 9-feet
246.9 Hz	= note B	octave 3	B before middle C	wavelength 4-feet 6-inch

Mid – (Approx. 250 Hz. to 5,000 Hz.)

261 Hz	= note C	octave 4	"Middle C"	wavelength 4-feet 3-inch
440 Hz	= note A	octave 4	Concert A tuning note	wavelength 2-feet 6-inch
1000 Hz	= NO note	octave 5	Reference tone for elec.	wavelength 1-foot 1/8-inch
1975.5 Hz	= note B	octave 6	voice lispiness	wavelength 6-27/32-inch
4186 Hz	= note C	octave 8	highest piano note	wavelength 3-7/32-inch

High – (Approx. 5000 Hz. to 20,000 Hz.)

5919 Hz	= note G flat	octave 8	'Brilliance' & 'Sibilance'	wavelength 2-3/16-inch
9956 Hz	= note E flat	octave 9	Metallic, Steel, "ouch"	wavelength 1-5/16-inch
16744 Hz	= note C	octave 10	Highest harmonic piano	wavelength 3/4-inch

Here's the Problem

To absorb 80–100% of a specific frequency, an absorbers thickness (fiberglass, mineral wool, etc.) must be a minimum of 1/4 the length of the frequencies wavelength.

The Universe demands this – it's just Physics!

A 1-inch thick absorber made from medium-density fibreglass, will be approximately 90+% efficient at absorbing frequencies from about 1000 Hz all the way up to 5000 Hz and beyond.

BUT... the same 1-inch thick absorber will be approximately 20% or less efficient at absorbing frequencies at 250 Hz, and somewhere around 15-10% efficient as the frequency goes lower.

NOTE: There are many other characteristics that go into or make an effective absorber, these too must be considered.

So why does this whole thing about wavelength and absorption matter?

There are two answers to that question.

1. There is no "Magic Material" that will absorb all frequencies evenly. In other words, absorption as a method of control MUST be considered as a multi-thickness and multi-materials solution.

   "If you don't like this answer – find another Universe!" In this Universe, Physics just works that way! This is not opinion it's Physics.

   If you need to control (absorb) 90% of frequencies from 1000 Hz upwards, it is relatively simple. Use 1-inch thick "fuzzy stuff." Not a very technical description but it gets the point across.

   If you need to control (absorb) 90% of frequencies from 1000 Hz downwards to say 200 Hz, it's still relatively simple. Use up to 4-inches thick of "fuzzy stuff" and space it out from a wall or ceiling by "x" amount.

   If you need to control (absorb) 75% of frequencies from 200 Hz downwards to say 40 Hz, it's not simple at all.

   The "fuzzy stuff" would now need to be so thick that very little of your room would remain. In this range of frequencies, mass (material weight) and de-coupling are the only things that can address the wavelength and innate power of these frequencies.

   Mass and de-coupling are the only things that low frequency respects.

2. Spoken word and voices, musical instruments and music itself, all have multiple frequencies within them.
   We don't have monotone voices (well most of us).
   We don't only pluck one note, on one string of a guitar.
   We don't listen to music that is only one note repeated forever.

   With this understanding of the complex sounds around us, it should be self-evident that if we only control (absorb) certain frequencies in a room, then the other frequencies that are being produced by the instrument or voice are not controlled at all, or at best are minimally controlled.

   If we only absorb from 1000 Hz upwards for example, than all the notes of say a piano, below this frequency are just bouncing around in the room completely uncontrolled and/or are escaping the room.

   If the uncontrolled frequencies are allowed to just bounce around in the room, the apparent effect will be a "building up" of tonality in the lower frequencies where they are not being absorbed – which will skew and alter (the rest of) the music and/or voice.

   Examples:

   A musical performance' subtleties, might be obscured by the 'phantom' tonality being produced by the acoustic environment.

   Ensemble playing might be adversely affected due to the distances between players and the shifted perception of what is heard by one another in the group.

   In home and semi-pro recording / mixing rooms the over-application of "fuzzy-stuff" (that we see everyday) is often the reason that so many of these small studios fail and go out of business. If you are just sucking out *'some'* frequencies with the fuzzy stuff – what about the others? How can you mix not knowing what you are hearing?

   An office or industrial unit in a commercial building might build walls that meet standardized Fire Code regulations. But will completely ignore how badly that particular wall assembly performs acoustically. Well, what about your other tenants on either side of a tenant that makes a lot of noise?

Calculated and proportional sound isolation and frequency control, whether by absorption, trapping, diffusion mass and de-coupling or a combination of all, is the norm in a well-designed acoustic environment.

This isn't a sales-pitch – its just Physics...!

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