Residential Quietude, the Top Luxury Requirement

Bonnie Schnitta

Postal:
SoundSense LLC
39 Industrial Road, Unit 6
P.O. Box 1360
Wainscott, New York 11975
USA

Email:
bonnie@soundsense.com

The acoustic requirements and laws and the secrets to meeting them for single and multifamily residences.

Introduction

Residential acoustic treatments, whether related to privacy or creating the optimal audio experience in a home theater, are no longer just a niche design element. Roy Furchgott in a *New York Times* article (2015; see http://goo.gl/7P4Ta8) identified residential acoustic treatment a top luxury item for a new residence. Residential acoustic treatments are also a legal requirement as defined by local noise and building codes and the Warranty of Habitability, such as in the New York Real Property Law §235-b. In fact, in 2007, New York City passed a new noise code that has won several independent awards including the National Hearing Conservation Association 2010 Safe-in-Sound Award. Charles Shamoon of the New York Department of Environmental Protection provided the plenary session paper at Inter-Noise 2012 to explain the code and how builders should comply with it (Thalheiner and Shamoon, 2012; see https://acousticstoday.org/plenaryShamoon). All single-family, multifamily, and mixed use properties must consider the parameters in which they are allowed to exist while also meeting the personal and budgetary needs of the inhabitants. "Quietude" is defined as the optimal acoustic environment and should be the end goal when designing any residential space. It is one of my favorite words. Although the most common demand for residential acoustic treatment is related to issues of disrupted sleep, numerous studies also show the negative effect of noise on an individual's health.

Research has used diverse case studies to illustrate how critical the need is for all environments to improve the quality of life.

- Numerous studies have demonstrated the adverse affect of noise in a classroom and with the child's reading scores (e.g., Bronzaft, 2004).
- Hospital acoustics and the importance of quietude in recovery have had numerous studies that have identified the connection between less disruptive noise and a faster recovery time. One of my favorite papers, as much for its content as for its title alone, is *In Defense of Sleep* (Solet, 2011). Hospital acoustic studies have also focused on the importance of speech intelligibility (Ryherd, 2013), demonstrating the obvious importance of speech intelligibility in hospitals, especially in emergency and operating rooms.
- Individuals with autism suffer from extreme sensitivity to noise. This is also true for children and adults with ADHD. Improved learning, behavior, and well-being occur when placed in an acoustically appropriate environment (Johansson and Lindegren, 2008).
- Cancer patients or those with thyroid disorders also have been found to become extremely noise sensitive. Typically, they are disturbed by low-frequency noises or vibrations. Through all the years that I have been doing residential acoustics, I found that when solving noise and vibration problems that were not audible or bothersome to others, it was often in a population of people that had been or were soon to be diagnosed with cancer or a thyroid problem. I presented these

All rights reserved. ©2016 Acoustical Society of America.

findings at the 169th Meeting of the Acoustical Society of America in Pittsburgh, PA (Schnitta, 2015). It was rewarding afterward when people who either they or their spouse had a thyroid problem approached me to express gratitude for the brief explanation of the phenomenon.

- The control of noise and vibration for industrial applications has been extensively researched for hearing loss prevention. The extensive work in this area was recently well summarized by William J. Murphy (2016).

The same level of insight, research, and understanding about quietude is slowly beginning to be applied to residential applications and becoming part of standards and laws. It has become more common for architects to consider quietude in their work, resulting in more studies and resources to provide the best products for their clients. Over the many years of observing construction, I have seen residential contractors go from viewing the acoustic treatment as a nuisance unnecessarily delaying their schedule to embracing us to provide a product that makes their client very happy.

It is the goal of this article to provide a factual foundation for "quietude" to facilitate the communication of the concept to the homeowner, contractor, architect, project manager, and owner's representative. A clear explanation, with examples, on why residential acoustics and vibration control should be nonnegotiable considerations in any residential building is included so that all parties involved with a project will realize both the importance and the possibilities of quietude within any budget.

As scientists, we are trained to mathematically model the signal and the noise. That mathematical foundation with supportive research in the field has led to understanding what creates a better wall or floor, whether by a product or method of installation. It is this understanding that prevents common problems that exist between the design and the installation stages of any construction that often result in costly mistakes or render the acoustical treatment ineffective. Even a rudimentary introduction to how sound and vibration interact with an environment will allow architects, designers, and contractors to effectively adapt to any changes or conditions that may occur in the field.

Basic Acoustic Criteria for Residential Construction

Sound transmission class (STC) and impact insulation class (IIC) are the two relevant measures used to quantify sound separation across a partition such as a wall or floor. STC is a measurement of an assembly's ability to attenuate or reduce airborne sound transmission. IIC is a measurement of an assembly's ability to attenuate or reduce impact sounds such as footfall noise.

STC

One common problem for homeowners and contractors when choosing the optimum product to achieve quietude is that users and clients often don't have the ability to translate frequently used acoustical terms and standards for practical applications. One example is STC. Specifically, STC is a single-number rating calculated in accordance with the American Society for Testing and Materials (ASTM) classification E413 for sound transmission loss by a partition such as a wall or ceiling. If the goal is to build a wall that prevents sound from entering one room from another, knowledge of the STC rating of materials used as well as how that wall is to be constructed is paramount. This is similarly true for floors, walls, windows, and doors. Whatever materials are utilized, it is equally important that they be properly installed to have a rating that meets at least the minimum requirements of a client.

Generally, the STC of an acoustic barrier can be interpreted with the following levels on the far side of the barrier from the source:

25 - Normal speech can be understood quite clearly
30 - Loud speech can be understood fairly well
35 - Loud speech is audible but not intelligible
45 - Loud speech is very faint
48 - Some loud speech is barely audible
50 - Normal speech is not audible, but amplified sound will be audible
60 - Minimum requirement to inhibit audibility of sound that is amplified

Examples of Some Standard Wall Construction and Associated STC

Books have been written about various wall configurations (Beranek, 1991; Harris, 1998). At this time, giving an acoustic value to standard walls, as shown in **Figure 1**, will facilitate the conversation of laboratory versus field results, something that is often overlooked or not understood.

Laboratory Versus Field Results

Most city building codes require the STC of the wall and floor to be 50. There are, however, two common problems with that simple requirement. The first is that a high STC

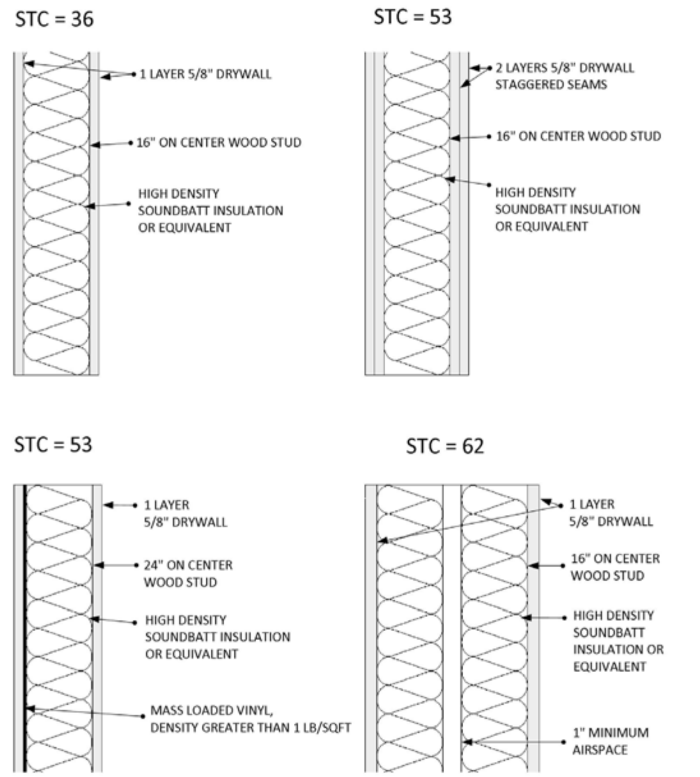

Figure 1. *Examples of standard walls and their sound transmission classes (STCs). The figure shows how walls are constructed to give different STC values.*

typically does not correlate to how well the barrier will perform at lower frequencies, such as for rooms with low-frequency mechanical sounds or amplified sound that will have a strong bass amplification, such as with subwoofers. The second is that in the field there are often small holes in a wall. These could be an electrical outlet or even the small space that did not receive caulk at the bottom of a wall where the drywall meets the floor that can typically degrade the ability of the wall to stop sound as engineered.

Once it is understood what common factors may impact the effectiveness of an acoustic treatment, incongruous results between laboratory and field tests can be established and verified. An explanation of why a wall separating two rooms intended for privacy as installed in the field does not always have the same value as determined by laboratory data was best said by Harris and Foundotos (1997) who wrote on page 73 in their book, "Airborne sound leaks, or flanking, are the most insidious problem in resolving sound transmission." Acoustic leakage, which is when sound travels a path other than directly through a wall or ceiling, can significantly degrade the performance of a partition. Basic testing throughout an installation can easily identify leakage points, preventing any costly mistakes or ineffective designs. At this time, for clarity of laboratory versus field results, the extensive research done at the National Canada Research Council (NCRC) is discussed (Gover and Bradley, 2006). To further clarify discrepancies between laboratory and field results, one of the many tests performed by the NCRC is provided in **Figure 2**. This example is worth noting because this is roughly equal to acoustically untreated electric outlets installed back-to-back.

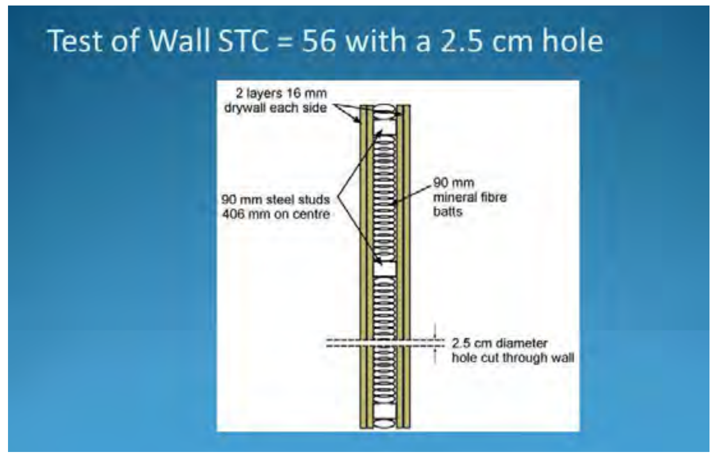

Figure 2. *Configuration of a test wall with 2.5-cm-diameter hole. The figure shows a wall that was constructed with a small hole to be tested for field sound transmission class (FSTC) degradation.*

Figure 3 presents the laboratory results from a one-inch hole that was created in a wall with a design STC of 56. The wall measured at a distance from the hole has a field sound transmission class (FSTC) of 51, but near the hole, the wall has a FSTC of 41.

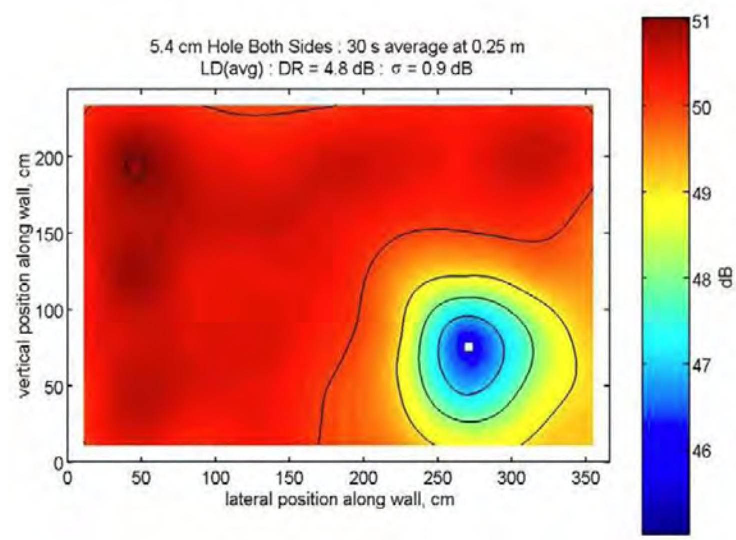

Figure 3. *FSTC results of* ***Figure 2*** *test wall with 2.5-cm-diameter hole. The figure shows the results of the FSTC degradation of as much 10 points due to the 2.5-cm-diameter hole. LD, level difference; DR, dynamic range; σ, standard deviation.*

The difference between these two readings is the difference between being able to hear someone talking through a wall or not. This reference to the extensive research at CNRC testing is included in this paper to demonstrate the importance of understanding the ASTM laboratory versus field ratings and the variables that create the difference between them. This difference in the results between the STC and FSTC not only emphasizes the importance of correct installation but also the importance of designing to the FSTC rather than just the STC for noise sensitive clients or applications.

Acoustically treating all seams or openings in walls and ceiling/floor configurations demonstrates the vital importance of a continuous site inspection and testing of an installation, often referred to in the construction world as construction administration. The purpose of construction administration is to ensure that the construction not only conforms to the construction documents but also to identify and resolve construction problems early. The focus on minimizing any acoustic leakage points should also consider light fixtures in a ceiling. The recessed lights should be in an insulated enclosure with a high STC. If this is not possible, there are mufflers available that can be installed above these "holes in a ceiling." Other simple examples of small holes in construction that are a source of acoustic leakage are back-to-back electrical outlets, the space under a door, or something as simple as pipes that run between floors. Whether it is a single- or multifamily home, pipes are often hidden in a shared chase or are in a wall behind which are ducts. When a duct or pipe passes through the floor/ceiling, a hole needs to be made to pass the conduit. If this hole is not properly sealed, sound will easily pass from floor to floor, diminishing the effectiveness of the acoustic treatment, as shown in **Figure 4**.

I once had a client complain about sounds from the floor above coming into the living room through the fireplace. The architectural drawings showed that all possible flanking paths of the fireplace had been properly sealed and were in compliance with the fire code. The flue was double insulated, which indicated that the sound was not emanating from the flue itself. After visiting the site, it became clear that there was a separate flue leading upstairs that for some reason was adjacent to the flue of the main fireplace in the living room. To accommodate the close proximity of the flues, the plywood originally specified and found on the blueprints to separate the two flues had been removed. When the damper was open, sound easily passed from one floor to the other.

Figure 4. *Picture of pipes passing through the floor creating a hole in the floor configuration. This figure shows a typical example of a small hole that degrades the FSTC of a floor, allowing sound to freely pass from one floor to another.*

In another instance, a couple who moved into an apartment above a restaurant tried to have the restaurant closed down due to the noise the restaurant was making. Initial tests showed the ceiling did not meet the building code because the holes drilled in the concrete during construction to allow water to drain had not been sealed closed. These were sealed closed along with a few other holes. The ceiling/floor now met code, but the couple was still disturbed by noise. Readings where then scheduled for a controlled experiment to play various music levels to set a limit on the volume. The restaurant was closed, yet music was still audible. This showed that the music that disturbed the couple at night was coming from a club on the first floor that was not below the couple but was two commercial units over.

Another example was when I had a client complain about hearing mechanical noise from the room below. There was some structure-borne noise, but there was also a great deal of airborne noise that should not have been present based on the design of the floor, which was 200 mm of poured concrete. On inspection, a pipe was found next to the unit that passed through the ceiling and cut through the floor into a wall above, as shown in **Figure 5**. There was only one layer of sheet rock between the pipe and the client's bedroom.

Although the pipe was cast iron, the hole that needed to be cut for the pipe to pass through the concrete was such that enough sound entered into the hole and into the stud bay above, making it possible for the sound to easily travel through the one layer of sheet rock and into the bedroom.

Figure 5. *Picture of a loud mechanical unit near a pipe penetration in the ceiling. This figure shows another example of how sounds from a mechanical unit can easily pass through a hole a pipe passes through that has not been acoustically sealed.*

IIC and Structure-Borne Noise

I have on numerous occasions been called in by contractors wanting to prevent footfall from being heard between floors of a home or multifamily dwelling. The contractor did what they believed to be the best action to provide a high IIC for their client and were disappointed, if not horrified, when the installation had inadequate results. Like the STC, the IIC is a single-number rating that identifies the ability of a floor partition to attenuate impact sounds such as from footfalls. Specifically, the IIC is derived from measured values of normalized one-third octave band sound pressure levels in accordance with ASTM classification E989. Also like the STC, the preferred minimum IIC is 50.

Typically, this audible footfall is a structure-borne problem, but if there is a major leakage point like a stairwell without insulation and an insufficient STC or uninsulated recessed lights, the sound of a footfall may travel by other routes, and it could be just an acoustic leakage problem or acoustic leakage and structure-borne. Like water, sound will take the path of least resistance and go through the openings at the perimeter of doors or electric outlets or where the cut in the floor for a HVAC duct vent cover is greater than the vent itself and is not appropriately caulked and sealed.

These acoustic leakage points can be found with infrared, as used by the Canadian laboratory (Gover and Bradley, 2006), with a patented sound-focusing mechanism (Schnitta and Israel, 2011), or illuminated by shining a bright light into what is a high STC wall, door, vent cover, floor, or ceiling. If light will travel through the partition or under the door, so will sound. For this reason, acoustic leakage paths, as discussed above, in any proposed construction should be addressed so the partitions specified perform up to their engineered STC and IIC.

This is a very difficult problem, especially for noise-sensitive clients. I have had a client turn off the heating and refrigerator and ask for complete silence in the room so I can hear a barely audible transformer buzz that they find extremely bothersome. It is not that they are hearing something that doesn't exist; it is that they are simply more sensitive to that particular frequency than most people. In many cases, a person will find this small distraction enough of a bother that they cannot be as productive as if that noise were not present. Typically, these issues are not identified until after construction is complete and a client has moved into the home. Often, it is a vibration or a subtle noise that is most noticeable when it is the one thing preventing the desired state of quietude. To a contractor or architect, this often is a result of a misalignment of client expectations and design goals. This is worth noting because communication with the client as to how to achieve quietude goals within their budget is just as important as the design of a space.

These are just a few examples of how even the most well-designed system can have flaws rendering it ineffective or not up to code if the acoustic installation is not tested for the proper seal.

Simple Demonstrations of Structure-Borne Noise and Airborne Noise

The acoustic problem can be both airborne and structure-borne. For the design team to understand the two-part nature of the solution set, a demonstration is often helpful. Architects, engineers, and contractors all need to have the language to explain the difference between airborne and structure-borne noise and the available options to address them. Most clients understand this after a simple demonstration.

The demonstration that sometimes I only need to mention and not even demonstrate is a garage door in operation. In the garage, the motor sound is audible and identifiable, but a few rooms away, this "motor sound" is no longer audible. What is audible is a low-frequency vibration rumble that is not the sound from the motor but the structure-borne sound from the rigid connection of the motor to the ceiling or wall of the garage. This helps to separate the conversation on what is airborne and what is structure-borne noise.

Another demonstration of structure-borne and airborne noise is to place a cell phone in full contact under a table in the middle of that table while on vibrate mode only and have someone call that cell phone. When the phone vibrates, there is a sound that emanates from the table. Often this sound can be quite loud. Once that cell phone is pulled just a ½ inch away from the bottom of the table, that sound disappears. If this demonstration is repeated with the ring volume on, it is not as impressive but shows that without the treatment of the airborne ring, the noise is still audible. This demonstrates the distinct but equally important aspects of how airborne sound and structure-borne sound are both part of the solution set in any installation but especially in residential design. The structure-borne aspect is often very difficult to eradicate once a vibration enters a structure, particularly with mechanical units.

Another wonderful example is to take two wood blocks that are each about a half meter long and 50 mm × 100 mm. Place them on the floor with two edges touching. Place one foot on one of the blocks. Tap the edge of that block with a hammer, not touching the other block. The wood with your foot on it will not move, but the other will move away, showing how energy can transfer from one structure to another.

Examples of Structure-Borne Noise

One of the most common examples of structure-borne noise is when the noise from mechanical equipment such as a condenser unit or pump in a room or closet is disturbing to an adjacent room even when the STC is sufficient to stop the sounds from the mechanical unit. Typically, this involves making certain that there are no rigid connections and that certain flexible connectors or spring isolators are properly installed as well as ensuring that the ceiling of the mechanical room has a sufficient STC with no points of acoustic leakage. This is where the demonstration of the cell phone on the bottom of the desk helps to explain the problem.

A common type of structure-borne vibration is experienced with footfall. There are many approaches to solve this problem. The floor can be floated or placed on a resilient material, such as recycled tires. When the treatment is on the floor side, sometimes a simple rug with an acoustic carpet pad underneath solves the problem. There are other times when the floor cannot be treated and the ceiling is then floated or attached using a connector that has some flexibility to it, such as resilient channels or a neoprene strip. Even though the solution is engineered to inhibit the structure-borne footfall from entering a room below, there are secondary parts to the engineered solution, such as where the floor or ceiling meets the wall. As engineers, we are taught to make certain that our acoustic design is not short circuited by a rigid connection. An example of that would be including proper resilient strips where the floor or ceiling meets the wall or replacing a resilient channel with a clip that includes neoprene that prevents the attaching nail from reconnecting to the structure. Despite the inclusion of this aspect of the design, there are many occasions that I have found where the floor or ceiling is not properly decoupled as was shown in the drawings.

Invisible speakers, or any sort of sound-amplifying device installed into a wall or ceiling, are a common source of airborne and structure-borne noise. The airborne portion of the problem is readily addressed by speaker backs with an STC of, but often the structure-borne noise is forgotten in the installation. By connecting a speaker directly to the channel which is connected to the drywall, there is nothing preventing the vibration from entering the structure of the room and traveling throughout the house even when used at a moderate volume. If the ceiling is constructed of drywall with regular paint, this may not be a problem. Vibration of the channel, however, is a serious problem if the ceiling is plastered, especially with a Venetian plaster. This is because over time the channel vibrations will cause cracks in the plaster, damaging the ceiling. A simple resilient strip that has a rated deflection, such as a simple antivibration pad made of neoprene or rubber, solves that problem by decoupling the speaker from the channel.

Elevators are a common source of such structure-borne problems if they are installed without proper isolators on the supporting structures or motors. When a motor is installed without proper isolators, this allows for vibration from the motor to travel into the I beam on which the motor is installed, which is resting on a wall that may be shared with an apartment or a room intended for quietude, such as a bedroom. This vibration is very difficult to eradicate because to just separate or decouple the walls from the elevator frame with an airspace does not address the aspect of what structure-borne piece is going into the floor as well as what is going into the ceiling. This may require changing the speed of the elevator in combination with decoupling the vibration that is going into the wall. If the wall of the elevator is not in direct contact with the floor, such as a concrete elevator shaft with a small airspace between it and an adjacent room structure, sometimes the acoustic solution to this structure-borne noise can be as simple as decoupling where the stud connects to the concrete wall.

What Is a Standard Ruler for Annoyance by Sound?

Up to now in this article, the goal has been to provide a foundation as to what goals should be set for STC or IIC. Possible failures in achieving those goals have been highlighted. The question remains: What is a disturbance? Annoyance by sound is a response to auditory experience. The standard acoustic ruler is that any noise that exceeds the background noise level by 5 dB(A) or more has the potential to be an annoyance. This applies to all forms of sound from people's conversations and automobiles passing on the street impinging on the street side of the house to mechanical noise to footfall from the floor above.

The doubling of the volume of a sound only shows a 10-point increase in decibels. For example, one TV set at a normal conversational level is about 60 dB. Ten TV sets at the same volume will sound twice as loud and register about 70 dB (**Table 1**).

Table 1. Subjective perception of actual sound energy change

Change, dB	Subjective Perception	Sound Energy Change, %
0-3	Barely perceivable	50
4-5	Perceivable and significant	69
6	Double sound pressure	75
7-9	Major perceived increase	87
10	Double loudness, 10× power	90

What does this really counsel us to do? On one hand, it is telling us that if your noise is 20 dB above background, a solution that takes care of 90% of the problem, as good as it may sound, still leaves a terrible problem. Additionally, it shows that if we can bring the noise to within 3 dB of the background sound levels when there is no noise, we may not need to spend a tremendous amount of money for total isolation. This perspective brings us full cycle as to the importance of putting great effort into inhibiting flanking.

Acoustic Environment

I want to conclude this article not with the problems and solutions for direct noise and vibration in a residence but with the importance of creating an appropriate, or hopefully ideal, acoustic environment. Once any intruding noise has been negated, this is often defined by the reverberation or decay time within a room or what distinguishes a vibrant sounding room from one that is offensively noisy. Reverberation is sound persistence due to repeated boundary reflections even after the source of the sound has stopped. Due to overlapping of successive syllables or tones, excessive reverberation reduces the intelligibility of speech and music within a room. People with a hearing impairment require a low reverberation time of about 0.4 seconds. Because an acoustic wave is a pressure wave, an acoustically correct space has a positive physical effect. I have had clients say to me, "I don't know why, but this room is my favorite. It feels so good." On the other hand, too little reverberation will make the room "dead." The ideal reverberation time for a room varies considerably and depends on several factors, such as personal preference, volume, or auditory constraint requirements.

Clearly, reverberation treatment is critical in rooms intended for any type of audio application, such as a home theater or media room, but tuning reverberation should also be addressed in dining rooms, large volume foyers, and even bedrooms. In fact, any room intended for sleeping, reading, learning, working, conversation, or any focused activity should receive reverberation analysis so that correction and optimization are incorporated in the final design. Ideal reverberation not only improves productivity and concentration but also provides a positive living and working environment.

The reverberation in a room should be corrected by mathematically modeling a room and positioning and applying acoustic material at precise locations on the surface boundaries of the room. Too little acoustic material will not make a noticeable difference and too much material will make the room feel uncomfortable and is a waste of money.

Conclusions

Quietude is one of the most grand and yet achievable treasures a person can have in his/her life. This quietude should begin in the residence of that person. Although definably subjective for every person, it begins with a properly engineered space.

This article was written to clarify some of the misunderstandings of ASTM laboratory tests and field conditions and the tests performed in the field for the full team involved in the design of a residential home. With clarification, the construction process can assuredly be engineered and then tested to make the process more successful. Some of the methods by which expectations can be adjusted for each solution will help make a step forward toward providing true quietude, whatever that may be for each individual, achievable.

Biosketch

Bonnie Schnitta received a BS in mathematics from Purdue University and a MS in mechanical engineering from Tufts University. She pursued a PhD at the University of Miami while working at the Institute for Acoustic Research, focusing on signal processing. In the 1980s, Bonnie began her acoustic engineering firm to fill the void she felt in residential acoustics. She worked to create a unique design-build acoustical engineering firm. SoundSense established an installation division to guarantee the optimum client-tailored acoustic environment based on the 2011 patented dB Focus Tube and testing methodology. SoundSense provides acoustic consulting, code compliance testing, and site inspection services.

References

Beranek, L. L. (Ed.). (1991). *Noise Reduction*, 2nd ed. Peninsula Publishing, Los Altos, CA.

Bronzaft, A. L. (2004). Noise pollution: A threat to our mental and physical well-being. *The Journal of the Acoustical Society of America* 115, 2567.

Furchgott, R. (2015). Soundproofing for New York noise. Real Estate Section, *The New York Times*, December 11, 2015.

Gover, B. N., and Bradley, J. S. (2006). *Detection of Localized Sound Leaks of 'Hot Spots' and their Effects on Architectural Speech Privacy (Speech Security)*. Publication 224, Institute for Research in Construction, National Research Council of Canada.

Harris, C. M. (1998). *Handbook of Noise Control*. McGraw-Hill, New York.

Harris, D., and Foundotos, Z. (Eds.). (1997). *Noise Control Manual for Residential Buildings*. McGraw-Hill, Boston, p. 73.

Johansson, O., and Lindegren, D. (2008). Analysis of everyday sounds which are extremely annoying for children with autism. *The Journal of the Acoustical Society of America* 123, 3299.

Murphy, W. J. (2016). Preventing Occupational Hearing Loss – Time for a Paradigm Shift. *Acoustics Today* 12(1), 28-35.

Ryherd, E. E., Moeller, M., Jr., and Hsu, T. (2013). Speech intelligibility in hospitals. *The Journal of the Acoustical Society of America* 134, 586-595.

Schnitta, B. (2015). Acoustic phenomena found in people with cancer and thyroid problems. *The Journal of the Acoustical Society of America* 137, 2320.

Schnitta, B., and Israel, M. (2011). *Sound Focusing Mechanism and Method of Estimating Acoustical Leakage of an Object and Method of Estimating Transmission Loss of an Object*. Patent 7,908,924 B2, filed October 14, 2003, and issued March 22, 2011.

Solet, J. M. (2011). In defense of sleep. *The Journal of the Acoustical Society of America* 129, 2636.

Thalheiner, E., and Shamoon, C. (2012). Understanding and complying with the New York City construction noise regulation. *Plenary Session, Proceedings of the 41st Congress and Exposition on Noise Control Engineering (Inter-Noise 2012)*, New York, August 19-22, 2012, pp. 1-14.

ASA books available through Amazon.com

The ASA Press is pleased to offer a select group of Acoustical Society of America titles at low member prices on www.Amazon.com with shipping costs as low as $3.99 per book. Amazon Prime members enjoy two-day delivery and free shipping.

To purchase ASA books quickly and easily follow these steps:
visit www.Amazon.com > select Books > enter Title in Search bar >
press on Title then New > choose the ASA Press listing

For more information and updates about ASA books on Amazon, please contact the Publications Office at **508-362-1211**.

ASA Press

ASA Press - Publications Office
1170 Main Street, P.O. Box 274
West Barnstable, MA 02668
508-362-1211