Canadian Audiologist
The Official Publication of the Canadian Academy of Audiology

Do We Really Need an Audiometric Booth?

Published November 19th, 2020

Alberto Behar, PEng

What is required to perform an audiometric test? ...an audiometer, a person to run the test (automatically or manually), and a booth.

Why a booth? Well, to reduce the background noise and, consequently, the number of false positive results that indicate hearing losses, when there are none. There is also another reason for the booth and that is to reduce the distraction of the patient from intermittent noises, such as conversations, the sounds of walking steps, honking, car engines, etc. The person being examined

has to concentrate to detect faint signals and to respond correctly as requested.

A low background noise spectrum is of such an importance as to be included in standards for audiometric tests. As an example, Table 1 in the latest CSA Standard for audiometric tests,[1] shows the maximum permissible sound levels at the different octave bands from 125 Hz to 8000 Hz. Two situations are included: use of a supra-aural earphones and insert earphones. Both earphones reduce the background noise; the second type more than the first. This is especially noticeable at low frequencies where the maximum permissible noise level using insert earphones is 29 dB higher at 125 Hz.

Table 1. Maximum Permissible Ambient Noise Levels for Audiometric Testing With Supra-Aural and Insert Earphones Used for Testing in the Frequency Range 500 To 8000 Hz

Maximum level (dB SPL)		
Octave band (Hz)*	**Supra-aural earphones**	**Insert earphones**
125†	49	78
250†	35	64
500	21	50
1000	26	47
2000	34	49
4000	37	50
8000	37	56

*The maximum noise levels by octave band specified in this Table are from ANSI/ASA S3.1.

†Audiometric testing at pure-tone frequencies below 500 Hz, if conducted, requires lower maximum ambient noise levels at octave bands of 125 Hz and 250 Hz than those specified in this Table. See ANSI/ASA S3.1

It has to be noted, that those values are maximum, meaning that they should not be exceeded at any time. In the case that such a situation occurs, the test should be interrupted and resumed once the noise levels drop below the limit. This is a situation found in rooms close to a corridor with audible traffic noise or with windows facing a street. This is also a frequent problem when mobile audiometric facilities are located in parking lots.

There are some inherent problems associated with audiometric sound booths. The first and most obvious, is the cost of the device; typically starting at $4,000. If the booth is to be located in a relatively quiet place and if the use is for routine, survey hearing conservations tests, then the cost may not be too high. However, in the case of clinical or research tests, or if the testing location is close to a shop floor, a double-wall device may be needed with a higher associated cost.

The second issue is the space it takes and its weight. Again, the more sophisticated the booth is, more space it requires as is its mass. If there is a need to also isolate the audiometric operator, then a double room is required and more space has to be allocated.

Claustrophobia is a situational phobia triggered by an irrational fear of tight or crowded spaces. It can be triggered by things like being locked in a windowless room, being stuck in a crowded elevator, or driving on a congested highway. Some worker/patients tend to feel claustrophobic and uncomfortable while seated in the audiometric booth

The third and perhaps the most serious issue is how to ensure that the background noise is within the recommended limits. This requirement becomes difficult to comply with when the location is exposed to non-steady noise levels. This is a regular problem with mobile audiometric facilities, frequently operating in busy parking lots. As per the above mentioned Standard (and, as a matter of fact, all current relevant standards) the background noise needs to be tested at least once a year to assure compliance. Unfortunately, not many booths are tested. To make things even worst, some studies claim that a significant percentage of the tested booths do not comply with the Standard.

Test Without Booths?

Is the use of an audiometric booth essential? The title of Table 1 states “Maximum permissible ambient noise levels…” without mentioning specifically “audiometric booths”. In other words, the issue is the value of the ambient noise level and not the way it is obtained. This is the reason for different solutions, others than the use of audiometric booths, being proposed. All of them have been tried by comparing results from tests performed inside booth with others performed with no booths. These studies claim that their results apply for screening tests only, where the objective is the detection of hearing losses above a set hearing threshold fence.

Studies of Solutions for the Problem Can Roughly Be Grouped As Follows:

Use of a quiet environment: Rural environments or small villages are known for being quieter than many typical urban centres (and interestingly enough, environmental noise levels in the community have dropped by 3 dB on average since the advent of public health measures during our current Covid19 situation). This author remembers auditing audiometric tests in a bauxite processing facility in Guinea. Tests were performed in an office, where he couldn’t perceive the faintest noise. This was an ideal location for performing tests even without a booth. Testing locations in health clinics or similar offices may not comply with the standard requirements for ambient noise level, but can be adequate for routine, supra-threshold screening procedures.

Some studies compare results from tests performed in such locations with others done in an audiometric booth. Their results show no significant differences supporting this assumption.

Use of insert headphones: The Standard allows for significantly higher ambient noise levels when insert headphones are used. This is because their attenuation is much higher. As a result, the limit for a broadband background noise is 63 dBA[1] while it is 41 dBA when supra-aural headphones are used.

Use of over-the-ear ear muffs: Ear muffs significantly reduce the ambient noise if they are well fitted. In some studies, the signal was fed through insert earphones located under over-the-ear ear muffs. In such circumstances the ambient noise is “twice attenuated”; by the insert earphone and by the ear muff. In some studies, results from tests performed in booths and using ear muffs over insert earphones were compared. The results were identical, supporting the conclusion that this is another booth-less way to perform audiometric testing.

Use of Active Noise Reduction (ANR) ear muffs: The ANR electronic technology relies on the principle of destructive interference to cancel noise. For that purpose a control microphone located under the ear muff’s cup picks up the noise that has penetrated the device. Its output is phase

shifted 180°, amplified and fed to a speaker, that in turn sends noise into the cup. In theory, the fed back noise should destroy the original noise. However, due to several limitations, the result is a significant reduction of low frequency noise (typically less than 15 dB) below 1000 Hz, but can be difficult to control by conventional means. It is a proven method used for hearing protectors especially in situations such as the interior of helicopters and military tanks. Low frequencies are known for causing upwards spread of masking, even affecting hearing thresholds at higher frequencies. As in the previously described studies, combined use of over-the-ear ANR ear muffs with insert earphones appears to be a valid replacement for the use of audiometric booths.

Advance technology: A relatively new device[2] on the market consists of a computer-controlled audiometer equipped with inserted earphones covered by circumaural protectors. Those are fitted with external microphones that monitor the environmental noise levels. The device also allows for interrupting the test if those levels exceed pre-set values.

In Summary

The “golden rule” for performing an audiometric test requires the use of a booth that assures a stable, controlled environment for performing any kind of audiometric tests. However, there are circumstances where booths are absent. Results of studies support the use of alternative means that allows obtaining similar results. The key issue is maintaining and controlling the background noise levels so that the hearing of the subject being tested is not affected.

Endnotes

1. The background noise has to be measured in octave bands and the limits in Table 1 have to be complied with. The values in dBA are an approximation, that could be used as an orientation for wide range frequency noises.

References

1. The Standards Council of Canada. Standard Z107.*6-16.* Audiometric testing for use in hearing loss prevention program. December 2016; Available at: https://www.scc.ca/en/standardsdb/standards/28746