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update

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So How Good are These Smartphone Sound Measurement Apps?

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Introduction

As of June 2013, smartphone penetration in the U.S. market has reached more than 60% of all mobile subscribers with more than 140 million devices. Apple iOS and Google Android platforms account for 93% of those devices [Nielsen, 2013]. Smartphone developers now offer many sound measurement applications (apps) using the devices' built-in microphone (or through an external microphone for more sophisticated applications). The ubiquity of smartphones and the adoption of smartphone sound measurement apps can have a tremendous and far-reaching impact in this area as every smartphone can be potentially turned into dosimeter or sound level meter [Maisonneuve et al., 2010]. However, in order for smartphone apps to gain acceptance in the occupational environment, the apps must meet certain minimal criteria for functionality, accuracy, and relevancy to the users in general and the worker in particular.

This study aims to assess the functionality and accuracy of smartphone sound measurement apps as an initial step in a broader effort to determine whether these apps can be relied on to conduct participatory noise monitoring studies in the workplace [Kardous and Shaw, 2014].

Experimental Setup

We selected and acquired a representative sample of the popular smartphones and tablets on the market as of June 2013. Smartphone apps were selected based on occupational relevancy criteria: (1) ability to report unweighted (C/Z/flat) or A-weighted sound levels, (2) 3-dB or 5-dB exchange rate, (3) slow and fast response, and (4) equivalent level average (Leq) or time-weighted average (TWA). Also, considerations were given to apps that allow calibration adjustment of the built-in microphone through manual input or digital upload files, as well as those with reporting and sharing features. Ten iOS apps out of more than 130 apps were examined and downloaded from the iTunes store as shown in Table 1.

App	Developer	Features
Adv Decibel Meter Decibel Meter Pro	Amanda Gates Performance Audio	A/C weighting, Int/Ext mic, Calibration A/C/Z weighting, Calibration
iSPL Pro	Colours Lab	A/C/SPL weighting, Calibration
Noise Hunter	Inter.net2day	A/C/SPL weighting, Int/Ext mic, TWA, Calibration
NoiSee	IMS Merilni Sistemi	A/C/Z weighting, ISO/OSHA, Dose, Calibration
Sound Level Meter	Mint Muse	A/C/SPL weighting, Calibration
SoundMeter	Faber Acoustical	A/C/SPL weighting, Leq, Int/Ext mic, Calibration
(Real) SPL Meter	BahnTech	A/C/SPL weighting, Calibration
SPL Pro	Andrew Smith	A/C weighting, Leq, Int/Ext mic, Calibration
SPLnFFT	Fabien Lefebvre	A/C/SPL weighting, Leq, Int/Ext mic, Calibration

Table 1. List of iOS smartphone sound measurement apps.

Four Android based apps, (out of a total of 62 that were examined and downloaded) partially met our criteria and were selected for additional testing. As a result, a comprehensive experimental design and analysis similar to the iOS devices and apps study above was not possible. In addition to the low number of apps available with similar functionality, there was a high variance in measurements and a lack of conformity of features of the same apps between different devices. Only a few apps were available on the Windows platform but none met our selection criteria.

The measurements were conducted in a diffuse sound field at a reverberant noise chamber at the NIOSH acoustics testing laboratory. For our experimental setup, we generated pink noise with a 20Hz – 20kHz frequency range, at levels from 65 dB to 95 dB in 5-dB increments (7 different noise levels. Reference sound level measurements were obtained using a ½-inch Larson-Davis (DePew, NY) model 2559 random incidence microphone. Additionally, a Larson-Davis Model

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update

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Message from the Chair: Healthy People 2020

By: Madeleine J. Kerr, RN, PhD

What is our progress with the Healthy People 2020 objectives for occupational hearing conservation? This was my question as I prepared my final Message from the Chair. New statistics were available for "Reduce new cases of work-related, noise-induced hearing loss" (OSH-10) (USDHHS, 2010). Citing the Survey of Occupational Injuries and Illnesses (SOII) by the Department of Labor, the report showed that we are half way to the year 2020 target of a 10 percent improvement in new cases, from the baseline of 2.2 down to 2.1 cases of work-related noise-induced hearing loss per 10,000 workers. Now this is news to celebrate! We are on our way to hearing health for all!

Then I recalled the hearing health disparities among occupational sectors. In the Fall 2012 issue of CAOHC Update, Elizabeth Masterson reported that the three industry sectors with the highest prevalence percentages of workers with hearing loss were

1) Mining, Quarrying, and Oil and Gas Extraction (27%),
2) Construction (23%), and
3) Manufacturing (20%) (Masterson, 2012).

Through CAOHC we are reaching the manufacturing sector because of OSHA regulations requiring hearing conservation programs. However, I wondered to what extent we are reaching the top two sectors with serious noise exposures. In the Summer 2008 issue of CAOHC Update, Scott Schneider described Hearing Loss Prevention in Construction and Demolition Work, the new ANSI standard A10.46-2007 (ANSI, 2007). This voluntary standard proposed a new approach to engineering and administrative controls, and hearing protection for this very unique work sector (Schneider, 2008). Read the article in the "Rewind" section of this Update and see if you agree that it is as relevant today as it was in 2008. CAOHC will continue to extend its reach into all industry sectors through publications like Update.

It has been my honor and pleasure to serve as Chair of CAOHC for the past two years while representing the American Association of Occupational Health Nurses (AAOHN). Now it's time to pass the baton to the new Chair. Please welcome Bruce Kirchner representing the American College of Occupational and Environmental Medicine (ACOEM) when he comes on board for the 2013-2015 term.

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So how good are these smartphone sound measurement apps? – continued from page 1

831 type 1 sound level meter was used to verify sound pressure levels. Smartphones were set up on a stand in the middle of the chamber at a height of 4 feet and approximately 6 inches from the reference microphone as shown in Figure 1.

Figure 1. The SoundMeter app on the iPhone 5 (left) and iPhone 4S (right) compared to ½" Larson-Davis 2559 random incidence type 1 microphone (center).

Results

In order to see which apps provided measurements closest to the actual reference unweighted and A-weighted sound levels, we compared the means of the differences using multiple pairwise Tukey comparisons, as shown below in Table 2.

App	N	Mean (dB)	S. E. (dB)	Mean (dBA)	S. E. (dBA)
Adv Decibel Meter	168	3.7875	0.25718	-5.0464	0.27668
Decibel Meter Pro	168	-8.6500	0.32718	-13.1708	0.27644
iSPL Pro	168	-7.4274	0.27222	-2.5792	0.25884
Noise Hunter	168	-12.2161	0.33186	-1.9280	0.27227
NoiSee	168	1.9702	0.29079	-1.1280	0.25253
Sound Level Meter	168	6.7649	0.29457	3.6083	0.27926
SoundMeter	168	1.7595	0.23338	-0.5185	0.12852
(Real) SPL Meter	168	-5.5857	0.30416	-13.1327	0.27929
SPL Pro	168	2.7851	0.23576	2.4863	0.11935
SPLnFFT	168	0.0696	0.35569	-2.2744	0.25715

Table 2. Means of differences in unweighted and A-weighted sound levels using Tukey multiple pairwise comparisons.

Discussion

The results reported in Table 2 show that the SoundMeter app had the best agreement, in A-weighted sound levels, with a mean difference of -0.52 dBA from the reference values. The SPLnFFT app had the best agreement, in un-weighted sound pressure levels, with a mean difference of 0.07 dB from the actual reference values. For A-weighted sound level measurements, Noise Hunter, NoiSee, and SoundMeter had mean differences within ± 2dBA of the reference measurements. For un-weighted sound level measurements, NoiSee, SoundMeter, and SPLnFFT had mean differences within the ± 2 dB of the reference measurement. The agreement with the reference sound level measurements shows that these apps may be considered adequate (over our testing range) for certain occupational noise assessments.

Overall, the Android-based apps lacked the features and functionalities found in iOS apps. This is likely due to the development ecosystem of the Android marketplace and users' expectations for free or low priced apps and the fact that Android devices are built by several different manufacturers.

Challenges remain with using smartphones to collect and document noise exposure data. Some of the main issues encountered in recent studies relate to privacy and collection of personal data, sustained motivation to participate in such studies, bad or corrupted data, and mechanisms for storing and accessing such data. Most of these issues are being carefully studied and addressed [Drosatos et al., 2012; Huang et al. 2010].

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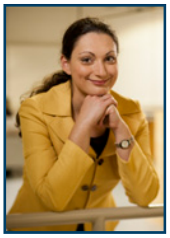

Evaluation of the Impact of Hearing Conservation Training

By: Dr. Naira Campbell-Kyureghyan; CARGI, University of Wisconsin-Milwaukee; Department of Industrial and Manufacturing Engineering

Training is an essential part of any hearing conservation program, and thousands of employees receive training each year on the importance of hearing protection. However, the effectiveness of that training is not often evaluated, even though it is a crucial step in providing programs that have a real impact on safety. Over the years various training evaluation models have been suggested, with Kirkpatrick's model of training evaluation criteria (1959, 2009) being one of the most popular and widely used models (Kauffman & Keller, 1994). The Kirkpatrick model proposes four stages of training evaluation: (1) reaction, (2) learning, (3) behavior, and (4) results. Recently the Consortium for Research in Gas Industries (CARGI) team at the University of Wisconsin-Milwaukee (UWM) proposed an expanded model (Figure 1) for training effectiveness evaluation that includes assessment of learning retention (Campbell-Kyureghyan, 2012, 2013).

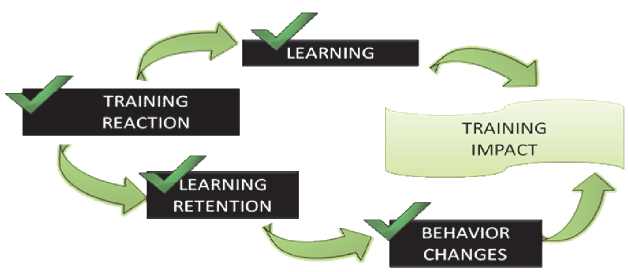

Figure 1. Five stages of training evaluation.

Each step of the evaluation process looks at a different aspect of training effectiveness at specific times. Training reaction assessments evaluate how the training is received by trainees and their perception of the usefulness of the training. Learning evaluates the change in knowledge caused by the training, usually through a written test. Both learning and training reaction are conducted at the conclusion of the training session. Conversely, behavior and learning retention are evaluated some time after the training to allow time for the training to either be incorporated into the trainee's knowledge base and behavior, or for the training effects to have faded. The time period can cover either short-term or long-term retention or changes, depending on the goals of the training. The behavior evaluation assesses changes in the performance of the trainee on topics covered in the training, and learning retention assessment repeats the learning evaluation. Finally, the overall impact of the training is judged through examination of objective measures such as the number of OSHA incidents or near misses experienced by the workers.

An example of the training evaluation process, and the insights to be gained, is a program where eighteen natural gas and propane small business utilities participated in targeted safety and ergonomics training. A total of 875 gas utility employees and contractors received a training session for "Noise and Hearing Protection" as a part of the larger training program. The same training assessment materials were used in each session and for the follow-up evaluations.

A feedback questionnaire was distributed to the trainees after training in order to assess training reaction. In addition, pre and post-training tests were administered to determine the effect of the training on trainee knowledge. The test consisted of ten questions, including one on hearing protection requirements. After the training, 84% of trainees were able to correctly answer the hearing protection question. However, during the learning retention evaluation tests, administered three to six months after the training, the percentage of trainees who were able to correctly answer dropped to 41% (Figure 2). The learning retention for this question was the lowest of all the test questions.

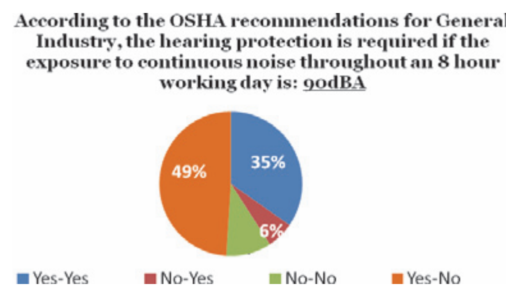

Figure 2. First and second post-test responses to the hearing conservation question. The responses are split into groups depending on their answers at each stage. The correct answer is "yes".

In addition to administering the learning retention test, field observations of behavioral changes were performed during same site visits. Interestingly, 98% of all observed trainees were wearing hearing protection in settings where the noise exceeded 90 dBA. Learning is an essential step towards a safer workplace and in developing changes in employee attitudes. If learning is not retained after the training, then worker attitude and behavioral changes are not likely to be evident. However, in this case we observed that while learning retention was poor, there were definite, positive changes in trainee behavior. How can we explain this apparent contradiction?

The CARGI team started the investigation by thoroughly reviewing the training materials. No factual deficiencies were identified in the training curriculum, but the hearing test question was found to have somewhat limited relevance to the trainees. While it is great to know the 90dBA limit recommended by OSHA for General Industry, the workers have no way of knowing when/where they are exposed to noise levels exceeding 90dBA. Therefore, remembering the exact decibel level where hearing protection is required is not essential for the workers. This explains why the learning retention component was not as good as for other test questions, but what is a reasonable explanation for the improved behavior regarding hearing protection?

As a part of the program the team trained not only employees, but also the managers and safety personnel in the facilities. It is their job to properly identify all the areas, tasks and conditions where hearing protection is needed. As a result of the training, management implemented administrative rules regarding where hearing protection was required. Therefore, while the worker training impacted their attitude towards hearing protection, and made them more aware of the need for it, the pre/post test question was oriented towards knowledge that was not necessarily linked to something that the workers could observe and measure themselves. This question was revised for future training sessions to address knowledge directly applicable to workers in the field. Thus, it was the combination of worker and management training, leading to greater awareness and improved work rules, which led to the improved behavior regarding hearing protection.

Summarizing the lessons learned from the training program:

- The effectiveness of a hearing protection program is highly dependent on employee behavior and attitude, as well as correct identification of the areas/tasks when one can be exposed to noise levels requiring hearing protection.
- Training is one of the components of the hierarchy of hazard/risk control. In some cases training cannot be effective by itself, but in conjunction with other factors, such as enforcement and engineering controls, can be an integral part of a safety program.
- While learning is a very important step towards generating behavior changes, the questions used to measure learning and retention should be targeted to knowledge relevant to the training population.
- In order to assess the training effectiveness, the training team should attempt to implement all 5 evaluation levels, and use the results to improve the training and to determine areas where additional training is required.

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Articles that will be selected must complement CAOHC's mission and goals and be relevant. We are interested in hearing about innovative hearing loss prevention programs, new innovations in training employees to be hearing conservation compliant, your challenges and your successes.

In addition, *UPDATE* places the "spotlight" on an outstanding Occupational Hearing Conservationist, Course Director, or Professional Supervisor. If you know of someone in your company that deserves the "spotlight" for their commitment to hearing conservation, please craft a brief testimonial (approximately 75-100 words or less) and include that person's name, your company name and a recent head-shot photo. Your "spotlight" candidate will be added to our next issue as well as posted to the CAOHC website.

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Thank you again for your interest in U*PDATE*!

Comparing Personal Attenuation Ratings for Hearing Protector Fit-test systems

By: William J. Murphy, Ph.D.; National Institute for Occupational Safety and Health

We live in an era of ever advancing technology. Smartphones, computers, and tablets afford the opportunity to integrate and implement new methods and techniques within the practice of occupational hearing conservation. Mobile applications to assess noise levels in the workplace and hearing protector fit-testing solutions for workers are significant advances that are beginning to gain traction in the workplace. This article will address hearing protector fit-testing and how it might be applied within a hearing loss prevention program.

Why should I fit-test workers?

The plethora of reasons for fit-testing may be distilled to four reasons: education, selection, application and documentation. First and foremost, the role of the hearing conservationist is to educate the worker. The OSHA Hearing Conservation Amendment mandates that all workers enrolled in a hearing conservation program shall be educated about the hazards of noise induced hearing loss (OSHA, 1983). Education through fit-testing allows you to interact with the worker, teaching them when to wear protection, how to fit protection and when hearing protection may not provide adequate attenuation. In fact, the OSHA-NHCA-NIOSH Alliance Best Practice Bulletin identified individual fit-testing as an emerging trend and best practice (OSHA, 2008). Once the worker's noise exposure is known, then you can proceed with selecting the protection best suited to that person. Not all employers will provide an extensive selection of earplugs or earmuffs. In these cases, fit-testing allows you to identify whether the worker can correctly wear the protection that is available. If the available protectors do not provide adequate attenuation, fit-testing can document this result and provide justification to seek other solutions. Fit-testing is one means to document that workers have received training and have demonstrated proficiency in fitting their protection. As a hearing conservation professional, you must understand the distinction between noise reduction ratings and personal attenuation ratings.

How is the noise reduction rating different from a personal attenuation rating?

The noise reduction rating (NRR) is a population statistic measured on 10 persons that describes the potential performance of a hearing protection device. The NRR is determined in a laboratory environment where the hearing protectors are fit by the experimenter to achieve the optimal attenuation (ANSI/ASA S12.6-2008). The NRR is determined using the mean and standard deviation of the group's attenuation at each frequency. Because the NRR is determined as an average across the subjects tested, it is not really relevant when applied to an individual worker fitting his or her own hearing protectors. A personal attenuation rating (PAR) can be estimated from an attenuation measurement at one or more than one frequency. To correctly use the PAR, you need to understand the different methods to measure attenuation, calculate the PAR and to estimate the exposures of your workers.

What Fit-test systems are commercially available?

In the United States, at least six fit-test systems are commercially available: EARFit™, FitCheck, FitCheck Solo™, INTEGRAFit®, SafetyMeter, and VERIPro™. These systems employ either objective or subjective methods to assess attenuation and each system uses different methods to calculate the PAR.

The 3M EARFit Validation System by 3M Company uses an objective method called microphone-in-real-ear (MIRE – see ANSI/ASA S12.42-2010 for a description of MIRE methods). The 3M EARFit Validation System was developed to test earplugs sold under the EAR, 3M and Peltor brand names. A loudspeaker sound source placed about a meter in front of the subject plays a broadband noise. The sound levels in the ear canal and just outside the earplug are measured with dual-element microphone. One microphone element measures the ear canal signal with a probe tube that passes through the center axis of the earplug. The second microphone element measures the external sound level and is suspended from a holder placed on a pair of glasses that the subject wears during testing. The difference between these two measurements allows the attenuation to be estimated.

The SafetyMeter Fit-testing System by Phonak also uses a MIRE method and is specifically designed to work with Phonak Serenity custom molded earplugs. The electronic package of the earplug is removable and is replaced by a microphone system to measure – inside the earplug – the sound output of SafetyMeter headphones. A second microphone placed in the headphones measures the sound outside the earplug. The difference between these two values allows the attenuation to be estimated. In addition to and independent of the PAR, SafetyMeter can identify whether or not the custom earplug is acceptable for use as a protector by testing the low-frequency attenuation at 125 and 250 Hz.

VeriPRO by Honeywell (Howard Leight) uses a psychophysical method called loudness balance to estimate the attenuation for earplugs with a sequential approach. Headphones are used to present tones that alternate between the right and left ears of the subject. The subject's task is to adjust the level of the tones such that they are the same volume in each ear or loudness balanced. The task is repeated for several frequencies (e.g. 250, 500, 1000, 2000, and 4000 Hz) and is performed for both ears unoccluded (no earplugs), right ear occluded (right earplug only), and both ears occluded (both earplugs in). The differences between the levels for the three conditions are used to estimate attenuation for each frequency and each ear. VeriPRO also provides a quick assessment mode that estimates the attenuation at 500 Hz.

FitCheck and FitCheck Solo by Michael and Associates estimate attenuation with the real ear attenuation at threshold (REAT) method using large volume circumaural headphones. In REAT, the subject must detect the presence or absence of a stimulus to measure the threshold of audibility for the stimulus. The difference between the occluded (hearing protection worn) and unoccluded thresholds estimates attenuation for each stimulus frequency. FitCheck and FitCheck Solo present a narrow band noise centered at octave band frequencies (125,

System	Method	Test Frequencies	Test Signal	To use PAR with A-weighted noise	Additional Notes
3M EARFit Validation System	MIRE	125 – 8000 Hz	Broadband Noise	Subtract directly	Provides 20th and 80th percentile confidence interval
FitCheck	REAT under Headphones	125 – 8000 Hz	1/3 Octave Band Noise	Subtract directly	
FitCheck Solo	REAT under Headphones	125 – 8000 Hz Typically 500, 1000 & 2000.	1/3 Octave Band Noise	Subtract directly	Provides a 95% confidence interval
INTEGRAFit	REAT under Headphones	500 Hz	Tone	Subtract directly	May underestimate protection for high frequency noises
SafetyMeter Fit-Test System	MIRE	125 – 8000 Hz	Broadband Noise	Subtract (PAR – 7 dB) directly	Subtract directly from Cweighted noise levels
VeriPRO	Loudness Balance under headphones	250 – 4000 Hz	Tone alternating ears	Subtract directly	

Table 1. Fit-testing systems, PAR measurement method and application to estimate protected exposure level.

250, 500, 1000, 2000, 4000, and 8000 Hz). The end user can modify which frequencies are tested with both FitCheck and FitCheck Solo.

INTEGRAFit by Workplace Integra also uses REAT to test attenuation. INTEGRAFit uses a 500 Hz tone rather than a narrow band of noise to test a subject's attenuation. INTEGRAFit is integrated with the Workplace Integra audiometer and uses a pair of large circumaural headphones to deliver the stimulus. The 500 Hz frequency serves as a sentinel frequency to identify the proper fit of an earplug (Royster et al., 1996; Joseph, 2004; Murphy et al., 2004).

How is the PAR applied?

In order to correctly use a fit-testing system with an existing hearing conservation program, one must understand how to apply and interpret the personal attenuation rating generated by your system. Each fit-testing system uses a different method to estimate the PAR. All PARs are based on the concept that the protector's attenuation is subtracted from the noise levels at different frequencies to estimate the user's protected exposure level when wearing a protector.

The fit-test systems, measurement methods, test frequencies, type of stimuli, and the application of the PARs are summarized in Table 1. Personal attenuation ratings can be C-weighted statistics, A-weighted statistics, or attenuation levels at each frequency. PARs that are A-weighted statistics can be subtracted directly from the A-weighted noise exposure levels to estimate a worker's exposure. The SafetyMeter PAR is intended to be subtracted from the C-weighted noise exposure level. Otherwise the SafetyMeter PAR would need to be adjusted to account for the difference between C and A weighting.

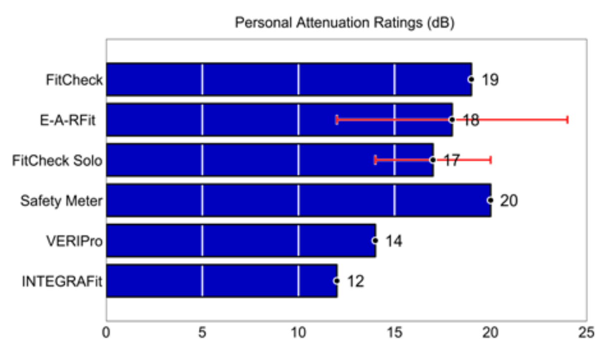

Figure 1. Personal Attenuation Ratings for six fit-test systems.

For purposes of illustrating the PAR, we assume that each system measures precisely the same attenuation that would be measured in a laboratory test of the subject's attenuation. The attenuations at each octave band frequency are 11, 13, 12, 17.5, 27.5, 33, and 22 dB from 125 to 8000 Hz. The horizontal bars illustrate the PAR values calculated for each system in Figure 1. For EARFit and FitCheck Solo, the error bars represent an uncertainty associated with the estimated attenuation. For E-A-RFit, the overall uncertainty is about 6 dB due to variability in the noise spectra, the user fit, and measurement method.[1] FitCheck Solo estimates the uncertainty when measuring fewer than seven frequencies, in this case, about 3 decibels. SafetyMeter's PAR is greater than the other PARs because it is calculated for C-weighted noise. VeriPRO is lower than most of the other PAR estimates due to the inclusion of an adjustment of 5 dB in the PAR calculation. INTEGRAFit reports the attenuation at 500 Hz, 12 dB.

The PAR values are applied to an example noise, 100 dB in each octave band from 125 to 8000 Hz, to estimate the exposure levels. If the levels are summed across frequencies, the unprotected exposure is 107.0 dB(A) or 107.9 dB(C) and the protected exposure level is 88.1 dB(A). The difference between the A-weighted unprotected and protected levels is 18.9 dB and is used to compare with the PARs from each system. The example PAR values do not underestimate the true exposure level. However, a different noise spectrum with the same overall level can result in exposure levels that underestimate the worker's exposure.

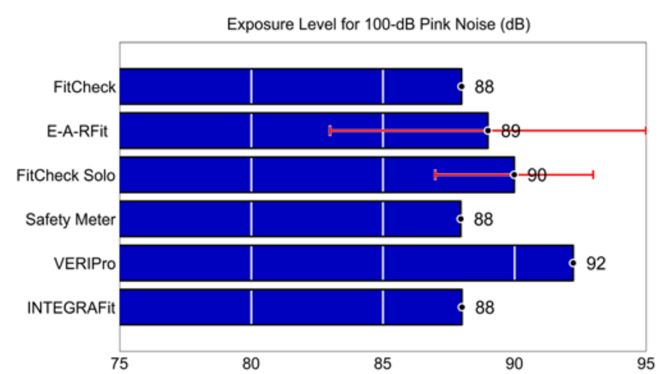

Figure 2. Estimated A-weighted Exposure Levels for six fit-test systems.

Gauger and Berger (2004) investigated the accuracy of twelve potential hearing protector ratings using a database of 300 reference noises. In their analysis, each rating produced a distribution of noise exposure levels for the different noise spectra. As a hearing conservation practitioner, you need to understand that the PAR is a guide to the possible protection and exposure that workers will receive. Once your workers return to their jobs, the hearing protection will be refit. The noise levels and spectra to which they are exposed will be different from what was used to estimate the PAR. Therefore, best practice should rely upon conservative estimates of the worker's estimated protected exposure level — the higher levels. As illustrated in Figure 2, the estimated A-weighted exposure levels are as follows: FitCheck = 88, EARFit = 95, FitCheck Solo = 93, Safety Meter = 88, VeriPRO = 92, and INTEGRAFit = 88 dB. Note that for EARFit and FitCheck Solo, the lower PAR value and the upper estimated exposure levels are used.

All of the estimated protected exposure levels exceed the NIOSH recommended 85 dB(A) exposure limit for an eight-hour workday (NIOSH, 1998). In the absence of noise controls or administrative controls, the worker should be trained to either achieve a better fit with the earplug or a different protector should be tried. A typical foam earplug will have an NRR that is more than 25 dB. With the exception of specialized musician earplugs, or impulse noise reduction earplugs, the majority of premolded earplugs have NRR ratings of more than 21 dB. Similarly, custom-molded solid earplugs typically have NRRs greater than 20 dB. If a worker is wearing a premolded earplug, then further instruction is needed to achieve a better fit. If the earplug is a formable foam earplug, then the worker should pay attention to how they roll and insert the earplug. The plug should be tightly rolled into a small crease-free cylinder and the pinna should be pulled up and back before inserting the earplug into the ear canal. If the worker is using a custom earplug, the earplug may not be fully inserted resulting in a slit leak and reduced attenuation. If the custom earplug doesn't extend sufficiently far into the ear canal, the attenuation may be reduced. If the custom plug is more than a few years old, the protector may have deteriorated or the worker's ear may have changed affecting the quality of the fit.

Fit-testing hearing protection can help you identify employees who are unable to properly fit hearing protection. Fit-testing will assist you in selecting appropriate devices that yield adequate protection. Finally, fit-testing provides an opportunity to educate employees about noise-induced hearing loss.

Footnote

[1] This variability is present in all of the fit-test systems but only the E-A-RFit system explicitly measures and presents this information.

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Captain William Murphy (Commissioned Corps of the US Public Health Service) is co-leader of the Hearing Loss Prevention Team (HLPT) at NIOSH and supervises a diverse group of engineers, scientists and audiologists. The Hearing Loss Prevention Team conducts a wide range of research related to hearing. He is the chair of the American National Standards Institute S12 Subcommittee on Noise and develops acoustical standards for testing and rating hearing protection devices. Captain Murphy is also a co-inventor of the NIOSH HPD Well-Fit fit-testing system that has been licensed for commercial sale by Michael and Associates as FitCheck Solo™.

NHCA Conference: A great opportunity!

By: Diane S. DeGaetano, BSN, RN, COHN-S, COHC, FAAOHN, CAOHC council representing the American Association of Occupational Health Nurses

Having heard from several of my CAOHC board members what a great experience the National Hearing Conference Association Conference can be, I was thrilled when I was offered the opportunity to attend. Every session I attended brought a new idea to me of how much more can be done in hearing conservation.

During the opening Panel Presentation: Hearing Protector Fit Testing, Laurie Wells of 3M pointed out there is not much new on the Regulations scene with regard to Hearing Protector Fit Testing and that the PAR – Personal Attenuation Rating is used in Germany and Canada as the hearing protector performance selector.

Jim Jerome of Workplace Integra discussed the importance of having solid noise measurements and to consider the following factors in providing the appropriate hearing protection (HP): variety, training both who and how, and the critical part of this activity – counseling.

Kathleen Thielen of Pepperidge Farms used a validation system for her hearing protection during a pilot and found that 40% of her employees were not wearing their HP properly. Theresa Schultz, Honeywell Safety Products, presented “Hearing Loss: The Basics” and noted that NIOSH provides best practice documents. She suggested that hearing protectors may be chosen by evaluating the following factors: size of ear canal, noise reduction rating, communication, comfort, job requirements and hygiene options.

John Casali, of Virginia Tech Auditory Systems Laboratory, discussed implications related to hearing and the NRR versus the Auditory Situation Awareness Factor (ASAF). In his research, he investigated detection, recognition, identification, localization, and communication to assess the ASAF.

Andrea Boldmar, Executive Director of Hearing Health Foundation, discussed the 2011 Hearing Restoration Project, one where researchers have been working on regenerating hair cells in adult mice. You may find more information by following this link: www.Hearinghealthfoundation.org.

On the International Scene: Elizabeth Beach, National Acoustics Laboratories in Australia presented “Sound Check Australia: A Citizen Science Approach to Noise and Hearing Conservation Research”. She and her colleagues, Megan Gilliver and Warwick Williams, teamed up with the Hearing Cooperative Research Center and Australia’s national broadcaster, ABC, to develop the science project. The project evaluated general and hearing-related health, exposure to occupational and leisure noise, as well as ototoxic exposure, attitudes towards noise, hearing loss and loud music venues. Forty percent of the nightclub goers reported experiencing tinnitus and a need to “shout to be heard”. Keila Knobel and Marcia Cecilia Lima, both of the University of Campinas, Brazil adapted the Dangerous Decibels education program for Brazilian children. Public school grades 3, 4 and 5 were given baseline questionnaires and another questionnaire immediately after a presentation on hearing and hearing loss prevention. The students exhibited significant improvement in knowledge and intended behavior related to Noise Induced Hearing Loss. These brief descriptions were just a small sample of numerous presentations available at this intellectually-stimulating and fun event!.

During Friday evening of the conference, we toured the Dali museum in St. Petersburg, FL and a live auction was held to raise funds for the NHCA Foundation for student scholarships. Ted Madison, of 3M, served as the auctioneer and was assisted by Theresa Schultz (see attached picture). I volunteered for CAOHC and manned the display booth, which afforded an opportunity to meet a number of new people. In closing, I would like to express my gratitude to the CAOHC Council for this excellent educational-conference opportunity.

Diane S. DeGaetano, BSN, RN, COHN-S, COHC, FAAOHN, Former CAOHC Council representative for the American Association of Occupational Health Nurses

CAOHC Group Page on LinkedIn

CAOHC Group Page Offers Discussion Forum and Information for Hearing Conservation Professionals

CAOHC is on LinkedIn! LinkedIn is the world’s largest professional networking website to connect with other professionals with similar interests. People who join the CAOHC LinkedIn Group Page can start and contribute to moderated discussions on hearing conservation-related issues. In addition, group members will get updates on CAOHC events and projects, as well as new connections to individuals in related fields of work.

To join the group, please go to www.linkedin.com. If you are not a member of LinkedIn, you can create a profile by clicking on the “Join Today” button at the top of the page. Once you are a LinkedIn member search for “CAOHC Group” and click the “Join” icon. Your request will be reviewed and approved by the group’s moderator.

Rewind

To celebrate CAOHC's 40th Anniversary, we are presenting a special section called *Rewind*. This section will appear within our social media outlets and–online newsletter, *Update*. *Rewind* will feature articles from previous issues of *Update* that contain information relevant for today's readers. As a follow-up to each article, a discussion thread will be started that invites readers to comment on the featured *Rewind* article.

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The Newsletter of the Council for Accreditation in Occupational Hearing Conservation
VOLUME 20 • ISSUE 2

Hearing Loss Prevention in Construction

Scott P. Schneider, MS, CIH
Director of Occupational Safety and Health Laborers' Health and Safety Fund of North America (LHSFNA).

Noise-induced hearing loss (NIHL) is a major problem among construction workers. (Schneider, et. al, 1995, Suter, 2002, Neitzel and Seixas, 2005) The National Institute for Occupational Safety and Health (NIOSH) has estimated that the average 25-year-old carpenter has the hearing of a 50-year-old with no noise exposure on the job. (Stephenson and Stephenson, 2001)

Contributing Factors

One reason that NIHL is a significant problem is because construction was exempted from the 1983 hearing conservation amendment (HCA) to the OSHA occupational noise regulation, 29 CFR 1910.95. Only Washington and Oregon require that construction companies meet the requirements of the HCA in their states. The federal OSHA regulation for noise in construction, 29 CFR 1926.52, requires only that employers in construction reduce noise levels to 90 dBA (8-hour TWA) or below and provide an "effective hearing conservation program" for those exposed above the TWA. Unlike the rules for general industry, the OSHA construction noise rule does not specifically define what employers must do to comply with the hearing conservation requirement nor does it require that construction workers exposed between 85 dBA and 90 dBA be included in program. Among 17,448 construction inspections conducted by OSHA in FY 2007, noise violations accounted for only 27 citations and $19,000 in penalties. Given OSHA's generally lax oversight of construction noise, it should come as no surprise that the use of hearing protection devices (HPDs) among construction workers is quite low (Neitzel and Seixas, 2005).

Another reason that NIHL remains a serious problem in construction is the transient nature of the workforce. A construction project can last a few days or a few years. Most are relatively short. Construction workers normally change employers and jobs frequently (one worker even had 13 W-2 forms in one year). Providing audiometric testing for workers who change employers and jobs frequently is a challenge. Many employers don't feel it's their responsibility to pay for the tests because they question whether the noise exposures on their site could have caused any hearing loss, and they want to avoid possible workers' compensation case. Even when construction companies do provide hearing tests, they often find it difficult to compare the worker's current annual hearing test with tests from previous years which were provided by one or more previous employers.

The intermittent nature of noise exposures in construction is another reason that the application of current hearing conservation standards is problematic in the industry. The noise levels on construction jobs can change from day to day as a project progresses (e.g., noise exposures will increase as a building becomes enclosed). While workers may qualify for being part of a program one day (e.g. have a TWA over 85 or 90), they may not the next. To be in compliance, a company would have to make regular (perhaps even daily) noise measurements at the job site, which is just not practical.

Finally, because of the gradual onset of noise-induced hearing loss, many employers consider noise less important than safety hazards, which kill over 1,200 construction workers a year and injure thousands more.

A New Standard Defines Best Practices

A new model has been proposed in ANSI standard A10.46-2007, Hearing Loss Prevention in Construction and Demolition Work. Unlike the OSHA approach to hearing conservation, where employers take action when noise exposures exceed defined exposure limits, the ANSI standard describes a task-based method of hearing loss prevention. Workers are required to wear hearing protection whenever they are performing tasks where exposures exceed 85 dBA, even for a short time. This means that employers can use a basic sound level meter to measure noise levels during a specific activity, instead of the more complicated and expensive method of measuring employee noise exposures over an entire work shift using dosimeters. According to A10.46, once noisy tasks have been identified, employers must post signs to warn workers where noise levels exceed 85 dBA.

Under the ANSI standard, employers must, to the

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extent feasible, use engineering and administrative controls to reduce noise levels to below 85 dBA. Where such controls are not feasible or do not reduce noise levels far enough, employers must give workers a choice of hearing protectors. The hearing protectors worn by the worker must be capable of reducing noise levels to 85 dBA or below, but no lower than 70 dBA in order to reduce the risk of overprotection. In calculating how much noise reduction is provided by the hearing protectors, employers should apply a safety factor or "derating" to the Noise Reduction Rating (NRR) as a better estimate of performance of hearing protectors in the workplace. Although the specific method for derating (e.g. NIOSH or OSHA) is left to the employer, several derating schemes are listed in the appendix. A specific derating system may be recommended once changes to the NRR have been implemented by the EPA.

Audiometric Testing Issues

Who should get hearing tests, who pays for them and who will keep the records are difficult questions in construction. It may be easy to address these issues in a unionized workforce where employers are already paying into a centralized fund for health benefits. However, in a non-union setting, the solutions are more difficult. ANSI A10.46 recommends audiometric testing for workers who have more than 30 days of exposure to noise above 85 dBA during the year. Many on the A10 committee felt strongly that all construction workers need to have annual audiometric tests. However, given the difficulties with providing such services in remote locations and the very transient nature of the workforce, the committee decided, for now, to only make this a strong recommendation. The standard also suggests that employers may be able to provide hearing test services using procedures similar to those used to conduct drug tests, lead screenings or medical exams for asbestos work. Employers are encouraged to use centralized facilities (e.g., internet storage) to make it easier for workers to access their records.

It is recommended in ANSI A10.46that workers receive training annually on the hazards of noise, noisy tasks, noise control measures, the proper use and fit of hearing protectors, the purpose and procedures of audiometry and the early symptoms of hearing loss. The standard also requires that hearing conservation programs be evaluated annually. Evaluations can include measures such as the number of workers exposed to noise above 85 dBA, the number of workers with a Significant Threshold Shift (STS) and the number of workers using Hearing Protective Devices. If the evaluation is negative, employers must reevaluate their hearing conservation efforts and noise control measures.

Need for OSHA Action

While ANSI A10.46 describes how construction companies can feasibly implement hearing conservation programs for their workers, it is a voluntary standard. Until such time that employers are required by law to follow the practices in the standard, it is unlikely that many employers will do so. For the past 25 years, noise-exposed workers in general industry have had the benefit of a comprehensive hearing conservation standard, 1910.95. In the last 5 years, OSHA has acknowledged that a new hearing conservation standard for the construction industry is needed and placed the issue on its list of long term action items. The time has come for construction workers to have the same protection as workers in general industry. We must continue to press OSHA to move forward and promulgate a new hearing conservation standard for the construction industry based on the practices defined in ANSI A10.46. Unfortunately, until OSHA acts, hearing loss will continue to be a major problem in construction.

More Information

Copies of ANSI A10.46-2007 can be purchased online from ANSI, at http://webstore.ansi.org/ or from the American Society of Safety Engineers (ASSE) at www.asse.org. Much more information on construction noise and hearing loss can also be found on the Laborers' Health and Safety Fund website www.lhsfna.org under "Occupational Safety and Health" and on Rick Neitzel's webpage at the University of Washington http://staff.washington.edu/rneitzel/.

Occupational Safety and Health Laborers' Health and Safety Fund of North America (LHSFNA). The Fund is a non-profit associated with the Laborers' International Union of North America (LIUNA) which represents 500,000 primarily construction workers in the US and Canada.

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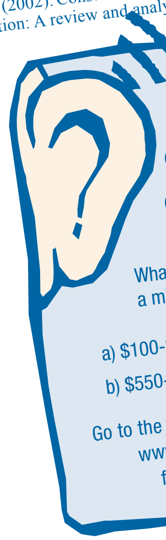

Hearing Conservation Quiz Question

What is the average price range of a microprocessor audiometer?

a) $100-$500
b) $550-$850
c) $1,500-$5,000
d) $5,000-$10,000

Go to the CAOHC website for the answer!
www.caohc.org/updatearticles/fall 2007/technology.php

To celebrate CAOHC's 40th Anniversary, we are presenting a special section called *Rewind*. This section will appear within our social media outlets and online newsletter, *Update*. *Rewind* will feature articles from previous issues of *Update* that contain information relevant for today's readers. As a follow-up to each article, a discussion thread will be started that invites readers to comment on the featured *Rewind* article.

Moving In...

CAOHC welcomes a new Council Member! John S. Oghalai, MD was recently appointed to serve as a CAOHC Council Member representing the American Academy of Otolaryngology – Head and Neck Surgery (AAO-HNS). Dr. Oghalai will begin his five year term in November and will work with other Council members to provide guidance on issues related to occupational hearing conservation programs, as well as the prevention and treatment of occupational noise induced hearing loss (NIHL).

Dr. Oghalai, is an Associate Professor, of Otology, Neurotology, and Skull Base Surgery in the Department of Otolaryngology - Head and Neck Surgery at Stanford University Medical Center.. In addition, Dr. Oghalai serves as the Stanford University Medical Director of the Lucile Packard Children's Hospital - Children's Hearing Center at Stanford. Dr. Oghalai's current research and scholarly interest include translational research to better understand the mechanism of hearing loss, improve patient care of those affected by hearing loss, and comprehensive evaluations of the pathophysiology as it relates to hearing loss.

Dr. Oghalai will serve as Council member for up to five years, with an opportunity to renew his term. He will join forces in leadership decisions with the full Council to continue CAOHC's efforts in promoting and enhancing occupational hearing conservation programs throughout the nation. The Council and Administrative Office value the time, dedication, and motivation provided by each member to CAOHC.

UPCOMING WORKSHOPS

Course Director Certification & Recertification Workshop

Wednes, March 12, 2014
JW Marriott Las Vegas Resort and Spa
Las Vegas, NV
Registration details can be found on CAOHC's website

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Leadership

The CAOHC leadership otherwise known as the Council consists of two representatives from each of the following Component Professional Organizations (CPO).

- **American Association of Occupational Health Nurses (AAOHN)**
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  John "Andy" Merkley, AuD CCC-A CPS/A
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