CAOHC®

Summer 2007

UPDATE

VOLUME 19 • ISSUE 2

The Newsletter of the Council for Accreditation in Occupational Hearing Conservation

Redefining the NRR: To B or to … A

By Dan Gauger

In the Summer 2003 *Update* Elliott Berger summarized a March 2003 workshop organized by the Environmental Protection Agency (EPA) to gather input prior to undertaking a revision to the Noise Reduction Rating (NRR) defined by the Hearing Protector Labeling Regulation. The process publicly begun by that meeting has continued, with much activity in support of the EPA by members of Working Group 11 (WG11) of the ANSI (American National Standards Institute) S12 committee. WG11, chaired by Elliott Berger, is chartered with responsibility for standards pertaining to hearing protector attenuation and performance.

Same Name, Different Rating. When the anticipated rule change goes into effect, the rating you see on a hearing protection device (HPD) package will still be called the NRR but, under the hood, it will probably be completely revamped. The purpose of a rating is to take a complex set of data, specifically the attenuation at different frequencies measured in the laboratory on a panel of subjects, and distill it to one or a few numbers that make it easy to compare HPDs and estimate, for a given device, the effective noise exposure of a population of users. At the request of Ken Feith of the EPA, WG11 produced an exhaustive report (Gauger & Berger, 2004) comparing the performance of many rating definitions. This report recommended two new ratings known as Noise Reduction Statistics (NRS). It is expected that the EPA will adopt them in a revised rule, though the NRR name will remain because the original enabling legislation dictates it.

The easiest-to-use new rating, designated the NRS_A, is applied, as the subscript implies, by simply subtracting it from the A-weighted noise exposure to estimate the effective protected exposure. By comparison, the NRR is designed to be subtracted from the C-weighted noise exposure, with an often-forgotten 7-dB adjustment that should be applied prior to subtracting it from A-weighted exposure values. For the devices that were predominant at the time the NRR was defined, this subtract-from-C approach is more accurate than a subtract-from-A rating, but this is not as true for the full range of devices in use today or anticipated in the future. Also, C-weighted exposure values are often not even known! Designing the rating for subtraction from A-weighted exposures eliminates these problems with the NRR.

Another key difference between the NRR and the NRS_A is that the new rating consists of a pair of values that indicate the range of performance inherent in the attenuation data; this range reflects both the variation across the subjects in the test panel as well as variation in noise level reduction with the noise spectrum in which the device is used. The majority of users will exceed the performance specified by the lower value in the range, with only motivated proficient users of the HPD able to achieve the quality of fit (seal) necessary to achieve or exceed the higher value. By providing a two-number range the NRS_A diffuses undue focus on slight rating differences when comparing devices, gives the HPD purchaser insight into which devices provide more predictable protection (as indicated by a narrower range), and hopefully will encourage more careful fitting of HPDs by showing what can be achieved with diligence. The NRS_A is anticipated to become the NRR on a revised primary label.

The 2004 report also describes a second rating, designated the NRS_G (G stands for graphical), that is recommended for use on the HPD's secondary label or in supplementary literature. This rating requires knowledge of both the C- and A-weighted noise levels and uses this extra information about the noise spectrum to more precisely estimate the two-number range of protection provided. The NRS_A is appropriate for typical industrial spectra; if one is considering atypical noise environments (e.g., dominated by low frequencies such as in airplanes or other vehicles) or if the level of noise is very high so extra certainty in the protection estimate is desired, then the NRS_G should be used.

WG11 has been drafting a new standard that codifies these ratings and defines how they are to be calculated and applied. This standard, which will be designated ANSI S12.68, will be put out for vote in the near future to the larger S12 committee and to ANSI.

Method A or Method B? A topic of considerable debate among manufacturers and experts on hearing protection is whether to base a revision to the NRR on "Method A" or

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Published by the Council for Accreditation in Occupational Hearing Conservation, a not-for-profit organization dedicated to the establishment and maintenance of training standards for those who safeguard hearing in the workplace.

Articles should be submitted with a black and white photograph of the author. The UPDATE is available to individuals not certified by CAOHC at an annual subscription rate of $30. Payment must accompany request:

555 E. Wells Street / Suite 1100
Milwaukee, WI 53202-3823
Phone (414) 276-5338
Fax (414) 276-2146
E-mail: info@caohc.org

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Chair's Message

By James D. Banach, MBA

The seasons have a way of shaping our perspective and expectations. They can lead us to a sense of quieting and preparing to weather the storm as winter approaches. As autumn arrives energy arises within us that makes us more prone to working in the coolness, being active and grabbing for the sun — as we know what's coming next. Right now, we are in that period where spring is waning and summer beckons. It is a time of possibility, of newness, of expectation.

If you are a gardener, the beds have had you on your knees, the roses have been pruned, and even some of the weeds are already challenging you. Ah, but the thought of that first fresh summer tomato makes it all worth it. Or maybe it is the anticipation of the aroma of the first fragrant rose. This is the time of year when we have to take time to absorb the warmth, the possibility to stretch a bit more than usual, be playful, and see what is out there. I wonder what comes to your mind as you ponder summer.

This issue of the *Update* lives up to the time and challenge of the season. We find ourselves going outside the usual exposure data, and consider the effects and concerns of fetal noise exposure. We can't approach this exposure with our typical application of hearing protection. Rather we face the need for a change in perspective and a different means of managing the risk. Even in the area of the long tried and true hearing protector, we now find ourselves on the verge of a realistic means for field evaluation of just how well those protectors are fit. A breakthrough… something new. And after years of research, papers, debate and discussion, could we be ready for new label ratings on hearing protectors, perhaps a truly useful number?

Often we get lulled into the day to day of hearing conservation, doing it the same old way, staying in the box of regulations and standards, forgetting to stretch a bit and go for what we really seek — a real impact that changes us from the patterned pace we are used to, to the energized, imaginative pace of summer. Maybe it is time for us to make up a new game… new rules… new energy.

And so it is for CAOHC. In November the Council will take some time for strategic planning to look at the big picture and make sure we are on course. It is an opportunity for us to assess changes we may need to make and holes we may need to fill. Some things come to mind, such as "how could we help other countries that are trying to establish a hearing conservation culture?" Or perhaps, "how can we manage training, evaluation and certification in a digital age?" "Is there a need for other levels of certification, or for other areas of function in addition to the OHC?"

Think Outside the Box. . .

I wonder what comes to your mind. Since this is a great season for day dreaming, I'm asking all our OHCs and CDs to do the same. Carve out a few moments and ponder the possibility of hearing conservation 'outside the box,' and of CAOHC stretching its mission. Let us know what comes into your mind. You can send an email to info@caohc.org with your suggestions and as we prepare for our strategic planning session, all will be considered. The Council surely isn't the source of all knowledge and good ideas, and while we often have to keep our eye on the day-to-day, this will be one of those times when we get to look up and consider the possibilities.

I hope you have a happy and safe summer season, enjoy the tomatoes, smell the roses, and listen to the birds. And please, find some time to be a kid.

Send your suggestions to info@caohc.org

OHC Corner

Hearing Conservation Checklist for Occupational Noise

By Ted K. Madison, MA CCC-A

Employees exposed to 8-hour time-weighted average (TWA) sound levels at or above 85 decibels on the A-weighting scale (dBA) should be enrolled in a hearing conservation program. This simplified checklist provides an overview of the main components of an effective hearing conservation program, based on U.S. Department of Labor requirements (OSHA 1983) and the recommendations of the National Institute for Occupational Safety and Health (NIOSH 1998). For more detailed information consult the OSHA Noise & Hearing Conservation e-tool online at: www.osha.gov or visit NIOSH online at:
http://www.cdc.gov/niosh/topics/noise/

Monitor Noise Exposure

Choose the best method for noise monitoring.

- Use a sound level meter (SLM) to identify sources of noise and determine which work areas are most noisy. The SLM provides a snapshot of sound levels at a single point in time. Measurements made with the SLM are most useful when sound levels are fairly constant.
- Use noise dosimeters to measure the daily noise dose of employees and describe how noise exposures vary over time. Since dosimeters move with the worker and measure levels over the entire work shift, they are ideal for situations where noise levels change throughout the shift and when noise exposures are intermittent.
- Identify employees exposed at or above the OSHA "action level" of 85 dBA TWA and notify them of the results. Since those employees may be at greater risk of developing a noise-induced hearing loss, they need to be informed, trained, and motivated to take appropriate actions to reduce exposures.

Provide Hearing Tests Annually

- Provide audiometric tests for each person enrolled in the hearing conservation program
  1. Document the baseline hearing test (audiogram) as soon as possible after noise exposure begins
  2. Re-test hearing annually and compare to baseline
- Audiometric tests should be performed by a qualified, CAOHC certified Occupational Hearing Conservationist. The certified OHC helps assure that the testing is done according to best practices and that the proper follow-up and reporting procedures are followed.
- Notify employees of results. Compliance with the requirements of a hearing conservation program is enhanced when employees are informed about the status of their hearing on an annual basis and maintain an awareness of what the consequences are, on a personal level, of losing their hearing. The OSHA noise regulation (OSHA, 1983) requires that, when the annual audiogram indicates that an employee has experienced a Standard Threshold Shift (STS) relative to the audiometric baseline, employers must notify the affected employee in writing within 21 days. In these cases, employers must also take specific steps to assure that the employee's hearing protection is adequate and that the employee is properly trained in its use.
- Refer employees for audiology or medical evaluation as needed. One of the key roles of the Professional Supervisor (of the Audiometric Component of the Hearing Conservation Program) is to identify those employees with conditions or audiometric configurations that suggest the need for more complete audiometric evaluation and/or medical examination.

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Dan Coleman, OHN AAAS BS COHC

OHC Spotlight

This month, the OHC Spotlight is on Dan Coleman, who became a CAOHC-certified Occupational Hearing Conservationist (COHC) in August 2006. As the Medical Service Supervisor, Dan performs audiometric evaluations and nursing assessments of all employees at Columbus Steel Castings in Columbus, Ohio. With 30 years of experience in nursing, Dan has seen many technological changes in industrial plants as well as in hearing conservation. He realizes that it is important to be safe on and off the shop floor. Recently, Dan said "it is imperative everyone take responsibility for their own hearing protection outside of work as one would do at work." Dan also reminded us that the most challenging aspect of hearing conservation is that the OHC be persistent and make sure that s/he doesn't 'drop the hearing ball' when they have employees followed up for further evaluation. This takes complete cooperation AND compliance from department heads, managers, and supervisors.

Dan has been involved in health and safety protocols for OSHA surveillance and has assisted in coordinating all aspects of employee health for over 21,000 plus employees as Employee Health Coordinator for the Cleveland Clinic. He also manages occupational disabilities.

In his spare time, he enjoys playing tennis and bridge.

HC Checklist – continued from page 3

Provide Hearing Conservation Training Annually

- Inform employees how engineering and administrative controls and hearing protectors can reduce their exposure to hazardous noise.
- Educate employees about noise, proper use of hearing protectors, and the importance of hearing testing.
- Verify that employees can use noise controls and fit hearing protectors correctly.
- Customize the training to the specific exposure and prevention situation of the group being trained.
- Use activities and techniques that help workers to understand how hearing loss may affect him/her personally.
- Workers are more likely to adopt behaviors that are associated with hearing loss prevention when they develop a belief that their actions will, in fact, lead to a successful outcome; and when barriers to implementing hearing health behaviors are removed. (Hong et al, 2005)

Provide a Variety of Hearing Protectors

- Offer at least two types of insert earplugs, one or more types of earmuffs and one other device – such as a semi-aural hearing protector. When employees have more hearing protection devices (HPDs) to choose from, they are more likely to find the type and model that fits comfortably.
- When TWA noise exposures are above 100 dBA, dual-protection (earmuffs worn over earplugs) should be required. (NIOSH, 1998) The extra protection provided by the earmuffs helps offset any acoustic leakage caused by a poor fit of the earplugs.

Selecting Hearing Protectors

- Select the most comfortable HPDs; they are more likely to be worn properly and worn during the entire duration of the noise exposure.
- Choose HPDs that are practical, easy-to-use, and compatible with other protective equipment being worn.
- Verify that the HPD is capable of reducing the 8-hour TWA noise exposure of workers to 85 dBA or less when worn properly.
- Focus on comfort; it is a better predictor of effective protection than the Noise Reduction Rating or NRR. (Arezes and Miguel, 2002)
- Reduce the NRR of insert ear plugs by 50% for a better estimate of the workplace noise reduction most wearers can achieve. For earmuffs, reducing the NRR by a safety factor of 25% is more appropriate since these devices are more likely to be worn correctly in the workplace. (NIOSH, 1998)

Keep Records of Hearing Conservation Program Activities

- Keep records of noise exposures, audiometric tests, calibration of the audiometric equipment, and hearing protector use for the duration of employment of the affected employee plus 30 years.
- Document recordable hearing loss cases on the OSHA 300 Log form (OSHA reg. 1904.10)

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Mr. Madison is employed by 3M Occupational Health and Environmental Safety Division as a Senior Technical Service Representative in St. Paul, MN. He is a representative on the CAOHC Council for the American Speech-Language-Hearing Association (ASHA).

Professional Supervisors are Certified by CAOHC

CAOHC is pleased to announce the first group of audiologists and physicians who have met professional requirements and completed CAOHC training and examination to be identified as a **Certified Professional Supervisor of the Audiometric Component of a Hearing Conservation Program.** This certification confirms advanced training in audiometric issues in occupational hearing conservation as a Professional Supervisor.

They have been awarded a certificate valid for five years and identified as a CPS/A. Those who have expressed approval to be listed on our website can be found at: http://www.caohc.org/ps/

A fall course will be held on Saturday, November 3, 2007 at the Sheraton Gateway Suites Hotel O'Hare in Rosemont, Illinois. All certification and registration information can be completed or downloaded at: http://www.caohc.org/professional_supervisor/course.php

CAOHC will be announcing additional courses for 2008. Questions may be directed to Barbara Lechner, CAOHC Executive Director, via e-mail at info@caohc.org or by phone to 414/276-5338.

Fit-Testing Hearing Protectors

By Elliott H. Berger, MS

INTRODUCTION

The question is how to select or assign a hearing protection device (HPD) to an individual user, taking into account his or her noise exposure, the amount of protection that is required, and potentially his or her hearing sensitivity as well. Today, hearing conservationists attempt to do this using labeled Noise Reduction Ratings (NRRs) that are provided by manufacturers in accordance with the Environmental Protection Agency's hearing protector labeling regulation (EPA, 1979). Though this might seem a reasonable approach it is fraught with error. The largest source of error is reliance on the EPA-required labeled values. These numbers are based upon an optimized fitting scenario in a controlled laboratory environment that bears little resemblance to the conditions under which workers wear HPDs on a daily basis, in what is often referred to as the real world (Berger, 1993).

The other key problem with the laboratory measurements, as commonly utilized, is that averaged (mean) values for a group of 10 subjects are used to predict the performance for an individual wearer in an occupational setting. Even if the laboratory data were representative of the actual group using the device, the individual variability is large enough that attempts at predicting one person's performance from group data can easily err by up to 20 dB (Gauger and Berger, 2004).

The answer to both of these problems is individual fit testing. This technology has been available in the laboratory in many forms for nearly 30 years (Berger, 1984; Berger, 1986; Berger 1988; Berger, 1989). Only recently has the hearing conservation community looked more closely at this issue and in fact there are now a number of potential systems that provide solutions.

METHODS OF INDIVIDUAL FIT TESTING

Historically the method of fit testing that has garnered the greatest attention is to replicate as closely as possible the laboratory test procedure. In the lab we ask listeners to track their hearing threshold levels (the quietest sounds they can hear) much like when they take a conventional audiogram to measure their hearing sensitivity. However, we present the sounds from loudspeakers in a test chamber and then repeat the procedure, both with and without HPDs. The difference in the two thresholds is the noise reduction of the device. This procedure is called real-ear attenuation at threshold (REAT) since the attenuation of the HPD is computed from differences in the threshold of hearing, with and without the hearing protector in place (Berger, 2000).

To take REAT into the field, we replace the loudspeaker presentation with a headphone presentation, i.e. speakers in large circumaural cups, and in so doing limit ourselves to being only able to measure earplugs. However, earplugs are the type of HPD that is most variable in fit and therefore most in need of fit testing.

A principal disadvantages of field REAT is its time-consuming nature since each frequency tested takes at least 30 seconds, a minimum of at least one minute to test the fit in each ear, much longer if multiple frequencies are to be tested. Furthermore there is an inherent variability since the data rely on the listener's ability to track his or her own threshold and that process itself has a substantial imprecision of approximately + 5 dB for typical employees. And finally, accurate REAT measurements require low background noise so that the open-ear thresholds are not masked and contaminated. Even though field REAT is conducted under large noise-excluding earmuff cups, care must still be exercised to be sure that the environment in which the tests are conducted is adequately quiet.

An alternative approach is to make objective measurements with microphones, what is termed a microphone-in-real-ear (MIRE) technique (Berger, 1986). When applied in occupational settings this becomes a field-MIRE (F-MIRE) methodology (Voix, 2006). With F-MIRE we simultaneously record the sound pressure levels in the earcanal under the hearing protector as well as those outside the HPD. The difference is termed the noise reduction (NR). With suitable correction factors to account for known and measurable acoustic differences between the F-MIRE and REAT, the NR values can be used to estimate the hearing protector's attenuation. A test system is shown in Figure 1.

A recent breakthrough in F-MIRE technology was the incorporation of a single small dual-element microphone

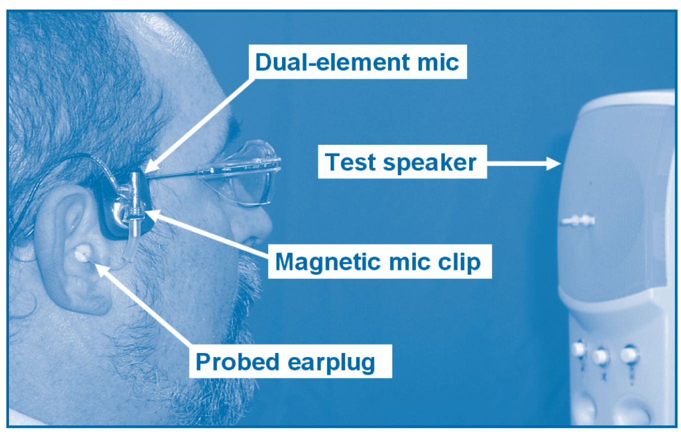

Figure 1: Illustration of key components of F-MIRE systen

and associated proprietary technology (Voix and Laville, 2002 and 2004; Voix, 2006). One section of the dual-element microphone couples through the earplug to sample the sound pressure levels in the earcanal, and the other section samples the external sound field. By developing special probed versions of standard earplugs we can now test in a matter of moments the attenuation that is being obtained regardless of the fit of the HPD that is being evaluated. The actual measurement for any

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"Method B." This refers to the two test protocols defined in the current attenuation test standard, S12.6 (ANSI, 1997). Method A is also known as "experimenter-supervised fit" and is an improvement upon the "experimenter fit" protocol in the now-obsolete S3.19-1974 standard specified by the current NRR regulation. Method B is also known as "naïve subject fit." It was developed as a laboratory test that better approximates the performance observed in the field or "real world" (Gauger & Berger, 2004, section 2.2). Many of the papers and opinions presented at the 2003 EPA workshop addressed the question of which of these two methods is the more appropriate basis for a revised hearing protector label (Suter, 2004). Data from either method could be used in calculating the new ratings.

In late 2004, William Murphy of the National Institute for Occupational Safety and Health (NIOSH) began organizing an interlaboratory study (Murphy et. al., 2006) at the request of the EPA and with extensive involvement from members of WG11. The purpose of the study was to compare the reproducibility between laboratories of Methods A and B. This was needed because prior studies had compared Method B to the S3.19 experimenter-fit method (Murphy et. al., 2004) and no data were available on Method A. The new study included six HPDs tested in six laboratories. The HPDs tested were foam, flanged and custom-molded earplugs, a canal-cap and two earmuffs. The laboratories and their representatives involved in the design of the study were NIOSH (William Murphy and David Byrne), E•A•RCAL (Elliott Berger), Howard Leight Industries (Brad Witt), USAF Research Laboratory (Rich McKinley), US Army Aeromedical Research Laboratory (William Ahroon) and Federal University of Santa Catarina, Brazil (Samir Gerges). The experimental protocol involved using the same set of 24 naïve (inexperienced in HPD use) subjects, first for the Method B test; then, after the experimenter trained and assisted the subject in the fitting of each HPD, for the Method-A test.

Figure 1 and Figure 2 (below) show the results for a foam earplug and an earmuff to illustrate the results of the study for all the laboratories. The filled and open triangles indicate lower and upper values for the NRS_A respectively; the lower values are also graphed with the error bars showing the interval within which the rating can be expected to fall with 95% confidence in future tests based on the variation in the data. The dashed lines

Figure 1: NRS_A for a Foam Earplug

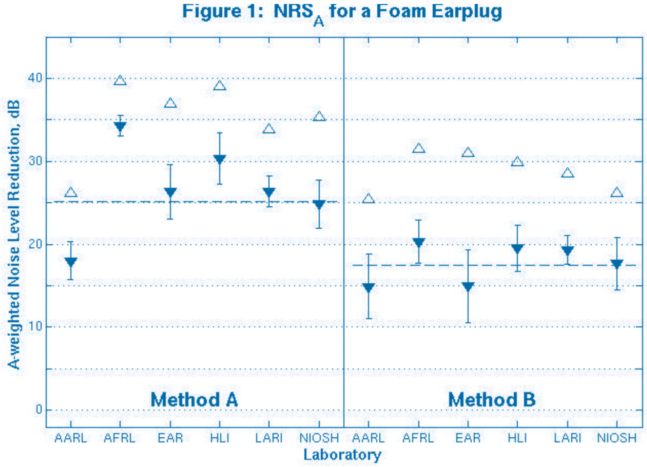
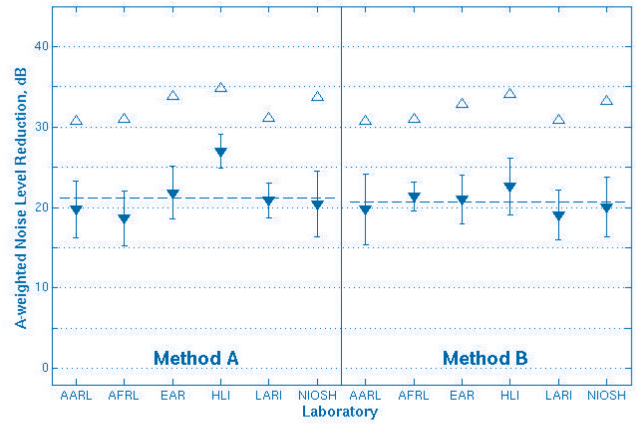


Figure 2: NRS_A for an Earmuff



represent the lower value obtained when the subjects from all six labs are combined into one large group; this represents the best estimate of the performance of the HPD.

Several observations follow from these graphs. First, note that the lower rating values (the solid triangles) are less than one typically sees for NRR values (29 dB for this plug, 27 dB for this muff), as expected with more realistic device fitting than called for in the current optimum-performance experimenter-fit procedure. Second, note that the rating values obtained from the two methods are very similar for the muff but not the plug; this is because of the greater instruction provided to the subjects prior to the Method A test and the greater sensitivity of plugs to the care with which they are fit. This also explains the wider range seen between the high- and low-rating values for the plug as compared to the muff. Finally, note the greater consistency of the Method B values across labs and particularly that the pooled-lab value (dashed line) comes much closer to intersecting the error bars for all labs with Method B than with Method A. On the other hand, note that the lengths of the error bars are slightly less on average for Method A than for Method B. These factors illustrate that a Method B test is more reproducible across different labs while Method A is more repeatable within the same lab, though problems with subjects that might be deemed outliers (those falling outside the expected statistical range) were noted in the Method B data.

What's next? WG11 has debated at great length the results of this study and which method to recommend the EPA adopt in a revised labeling regulation. In the end two conclusions were reached. First, WG11 realized that the interlaboratory variability of Method A needed to be improved; a revision to ANSI S12.6 is in process to address this by better standardizing the interaction between subjects and the technician conducting the test. Second, the group recognized that the choice of Method A or B is not purely technical but a matter of public policy; it thus chose to present to the EPA the arguments in favor of each. In brief, Method A provides a quicker, lower cost test that best estimates the device's inherent capacity to reduce noise. It is also less variable on repeated tests within the same laboratory. Method B provides the best estimates of the attenuation HPDs provide in the real world and thus their

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Fit-Testing Hearing Protectors – continued from page 5

one fit in one ear takes about 10 seconds to obtain data at the standard seven test frequencies from 125 Hz to 8 kHz, as well as an overall noise reduction rating called the PAR (Personal Attenuation Rating). In addition to the brevity of the test it can be conducted in substantially higher noise levels than can a field REAT measurement.

The PAR, though it appears to be an exact number, also contains its own variability, albeit much less than in the classical approach of using mean laboratory data for individual field predictions. The exact amount of variability in PAR is defined and explicitly provided with the measurement.

PURPOSE OF INDIVIDUAL FIT TESTING

Individual fit testing serves many purposes in a hearing conservation program, but first and foremost it is a tool to train and motivate employees to wear their hearing protectors. A common shortcoming in hearing conservation programs (HCPs) is lack of training; even when training is attempted, lack of ability to demonstrate that the training has accomplished its goals presents a problem. With a quick and accurate fit-testing system, like F-MIRE, the hearing conservationist has a valuable tool to select the proper hearing protector in terms of fit, and then to work with the employee to make sure s/he has the knowledge and skill to repeatedly insert the product correctly. In turn this helps motivate the employee since they come to believe in the efficacy of their own behavior, i.e. it is worth the effort to do these things … "I can make a difference."

Not only do the employees need training in the use of their HPDs, but so do the trainers themselves need to learn how to train others. This train-the-trainer application is a key feature of the F-MIRE approach. Now trainers can learn what makes a difference and how to direct users to get the most from their hearing protection.

Beyond correct fitting, the hearing conservationist may wish to assign HPDs based on noise exposure levels and/or the need to communicate clearly. In fact European and Canadian standards (EN 458 and CSA Z94.2-02) specifically make such recommendations to match the HPDs attenuation to a 15-dB wide target protection window. Without individual fit test data like the F-MIRE can provide, this matching of HPD to noise exposure/communication scenario is a folly. With the reliable octave-band attenuation and PAR that the F-MIRE estimates, such HPD matching is now feasible and reasonable.

When employees experience an OSHA-defined standard threshold shift (STS), one of the follow-up actions is to refit and retrain employees in the use of their HPDs and to provide more protective devices if needed. Now this can be done with a degree of reliability using F-MIRE to determine if, in fact, employees need this retraining to assess the protection they can obtain, and whether more is needed.

Companies are also often concerned if they are meeting OSHA requirements for adequate protection. The regulation directs them to use the labeled NRRs in spite of their unreliability. Alternatively, when OSHA compares the relative efficacy of HPDs and hearing conservation, the employer is directed to derate by 50%. Neither approach is accurate. The F-MIRE alternative, though not yet approved by OSHA, is likely to become accepted because of its much greater face validity. This is an area that must be addressed at the federal level.

Although F-MIRE is ideally intended for individual application there are times when a company may wish to audit a department or facility. F-MIRE could be applied on a large-scale basis by testing employees in a group and statistically summarizing and reviewing the results. Action could then be taken on an as-needed basis.

A final application of F-MIRE is for documentation for legal purposes. Though not yet tested in court, the concept of documenting the training and validating that an employee was able to demonstrate correct and adequate use of a hearing protector, would likely be valuable evidence in workers' compensation proceedings.

FINAL REMARKS

For over a quarter century, since the advent of modern hearing conservation regulations, we have been saddled with the knowledge that many hearing conservation programs are ineffective. Too often this is due to the simple fact that the key component of those programs, the object between the employee and a hazardous noise exposure, namely the hearing protector, is not doing its job. Worn correctly and consistently, HPDs can prevent noise-induced hearing loss in virtually all cases. A giant step in the resolution of this problem is individual fit testing and F-MIRE now makes that possible.

F-MIRE represents the next step forward in hearing conservation. It is not a panacea, but applied judiciously and consistently in one's overall hearing conservation efforts, the utility of such a tool is undeniable. As its use becomes more widespread, it is quite possible that such testing may become the standard for judging effective hearing conservation programs.

This article was previously printed in Hearing Review, March 2007.

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Elliott Berger is the Senior Scientist, Auditory Research for E-A-R/Aearo Company, Indianapolis, IN. He developed, and currently manages, the E-A-RCALS$_M$ Acoustical Laboratory. He has authored over 60 journal and magazine articles, hearing-protection chapters in eight text books, the on-going EARLog Series, and was the principal editor for the 4th and 5th editions of the American Industrial Hygiene Association's Noise Manual, and is the editor of the 4th edition of the CAOHC Hearing Conservation Manual. He may be contacted via e-mail at: eberger@compuserve.com.

Certification Workshop for Course Directors Scheduled for Fall 2007

The Council will conduct a Course Director Workshop on Friday, November 2, 2007 at the Sheraton Gateway Suites Hotel O'Hare in Rosemont, Illinois.

The Course Director (CD) is the individual responsible for planning and conducting training courses for OHCs and ensuring that specific CAOHC guidelines are followed. Course Director certification and recertification is granted for a five-year period.

This workshop is a requirement for certification of new and recertifying Course Directors. Attendees are to submit an application and fee for approval by the CAOHC Screening Committee prior to the workshop. Application and registration is available on-line at www.caohc.org.

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relative performance as used in the field. As such, Method B eliminates the motivation for derating of HPD ratings such as the 50% multiplier recommended for the current NRR by OSHA, while Method A only reduces it.

Mr. Feith and the EPA, along with their technical advisors at NIOSH, are waiting on WG11's revision of Method A before completing the re-writing of the labeling regulation. After the notice of proposed rulemaking is published, the public will have an opportunity to comment before a final review and the rule's eventual implementation.

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Dan Gauger is Research Manager, Noise Reduction at Bose Corporation where he has worked since 1980. A graduate of MIT (MS, BS, EE) he has spent most of his career involved in engineering and management activities connected with active noise reduction and audio headphones. He is an indefatigable participant in the Acoustical Society of America, S12 WGs 11 and 14 and has several patent applications in process.

OHC Spotlight and YOU!

If you would like to be considered by the editorial staff for a future "OHC Spotlight" feature, please contact Barbara Lechner at the CAOHC office by e-mail: info@caohc.org or by phoning 414/276-5338.

Loud Sounds May Damage the Hearing of Unborn Babies

By Kenneth J. Gerhardt, PhD

The impending birth of a new baby is an exciting yet stressful event. A thousand thoughts go through the minds of pregnant women during those critical nine months before delivery. Will my baby have all of his fingers and toes? Am I eating the right foods? What things should I avoid? Should I play music to the baby to enhance intelligence and creativity?

The last thing a woman wants to think about is the possibility that loud noises may damage the hearing of her unborn child. This concern has been raised in a number of contexts including recreation, military, industry, hunting, law enforcement, etc. So what do we know about the transmission of sounds into the fetal inner ear, and can intense noise exposure damage hearing?

The fetus is surrounded by the tissues and fluids of pregnancy. Fluids in the uterus can be found in the middle ear during later gestation thus reducing the effectiveness of the middle ear system. Yet, sounds pass through the uterus and stimulate the fetus.

To assess the extent to which sounds in the maternal environment are present at the head of the fetus, measurements of stimuli (speech, noise, music, etc.) were made simultaneously with a standard microphone in air and underwater (using a microphone called a hydrophone) located near the head of the fetus. The most careful studies of sound transmission into the uterus were conducted in sheep (Peters, et al., 1993; Vince, et al., 1982) while others have been conducted in humans (Querleu, et al., 1989; Richards, et al., 1992). Sheep serve as an excellent animal model for this type of research because, like humans, the fetus begins to hear during pregnancy and the dimensions of the abdomen of human females and sheep are similar. Results indicated that low-frequency sounds, below about 500 Hz, easily penetrate to the fetal head with little reduction in sound pressure level. Higher frequency sound pressure levels, above 500 Hz, are attenuated by 15-20 dB, as shown in Figure 1.

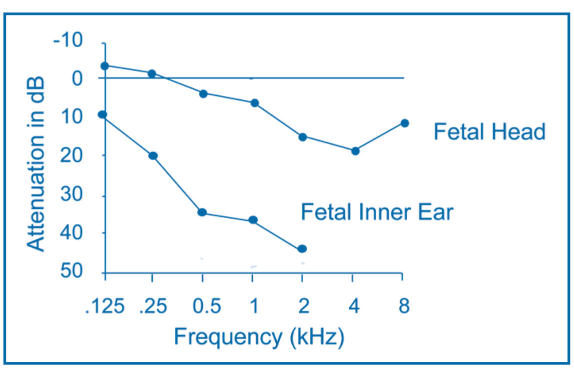

Figure 1: Results of fetal hearing testing results in sheep. (Gerhardt and Abrams, 1996) The upper curve represents the difference in sound pressure levels recorded in air and with a hydrophone by the fetal head. The lower curve represents the difference in sound pressure levels required to produce equal electrical amplitudes recorded from the fetal inner ear and then from the newborn lamb.

Characterizing the sound pressure level at the fetal head is only part of the story. Understanding the effect of those pressures on the inner ear is more complicated. One way to do this is to measure a small electrical voltage generated in the inner ear. With an electrode placed on the inner ear, it is possible to record an alternating current that is generated by the inner ear in response to sound present at the head. This response resembles the sound in amplitude and frequency and is called the cochlear microphonic (CM).

How much sound energy penetrates to the fetal head and stimulates the inner ear? To answer this question, measurements of the CM produced by narrow bands of noise delivered in air to the flank of pregnant ewes were obtained from fetal sheep in utero, and again after the lambs were delivered and their ears cleared of fluid (Gerhardt, et al., 1992). By comparing the CM amplitudes recorded from the inner ear of the fetus and then the newborn lamb, it was determined that the fetus hears predominately low-frequency sounds. High-frequency sounds are greatly attenuated as indicated in the figure.

The curve labeled fetal head indicates the attenuation produced as sound passed through the uterus and is recorded at the entrance to the ear. The curve labeled inner ear represents attenuation of a sound from outside of the ewe to the inner ear. The pattern of attenuation seen here is not unlike that provided by conventional hearing protectors (less attenuation at lower frequencies than at higher frequencies).

What happens when pregnant women are exposed to intense sounds? Is the fetus at risk even though it appears to be isolated from the high-frequency sounds that are present in the mother's environment? Scientists at the University of Florida studied the effects of steady-state, long duration exposures (Gerhardt, et al., 1999) and impulse noises (Gerhardt, et al., 1998) on fetal sheep. Pregnant sheep were anesthetized and the fetal head was extracted through a mid-abdominal incision. Recording electrodes and a water-tight transducer used to elicit auditory brainstem responses (ABR) were secured to the fetal skull. A hydrophone was sutured near the ear. The fetus was returned to the uterus, and the wires and electrode leads were tunneled under maternal skin and exited through an incision at the flank. The incisions were closed and the ewe was taken off anesthesia and permitted to recover. All testing and noise exposures were conducted in a sound-treated booth. After noise exposures and ABR testing, the cochleae were removed from the fetuses and prepared for scanning electron microscopy.

In both studies, pregnant ewes were fitted with hearing protectors during the noise exposures. Some preparations were exposed to 120 dB, 16-hour broadband noise. In other studies, pregnant ewes were exposed to 20 rounds of howitzer-level impulses (170 dB peak) produced by a shock tube. Results in both experiments showed threshold shifts in the ABR and structural changes of the fetal inner ear. Cochleograms from the fetuses revealed hair cell loss in the low-frequency portion of the cochlea (apical) rather than in the high-frequency (basal) portion. Most likely, the low-frequency components of these exposures produced the cellular damage found in the apical turn. In other words, the intense, long duration, low-frequency sound exposure caused damage to the fetus which would have manifested itself as hearing loss.

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ACOEM Confirms Role of the Professional Supervisor

Noise is one of the most ubiquitous work-place exposures, and noise-induced hearing loss (NIHL) is one of the most prevalent occupational medical conditions. Prevention and early detection of this condition should therefore be a priority for occupational medicine. The American College of Occupational and Environmental Medicine's (ACOEM's) statement about noise-induced hearing loss stresses the role that occupational medicine clinicians play in professional supervision of audiometric surveillance conducted under the auspices of hearing conservation programs. This document reviews the regulatory and scientific basis for this supervisory role. ACOEM believes that the functions of a professional supervisor in hearing conservation programs are part of the "core practice" of occupational medicine.

ACOEM therefore recommends that occupational medicine training programs ensure that current trainees achieve competency in these areas, and that occupational medicine professionals in practice utilize continuing medical education programs as necessary to address these competencies. The Council for Accreditation in Occupational Hearing Conservation (CAOHC) has created a scope of practice document for professional supervisors and a training course for physicians and audiologists leading to CAOHC certification as a professional supervisor of the Audiometric Component of Hearing Conservation Program (CPS/A). ACOEM has been a joint sponsor of this training at the annual American Occupational Health Conference.

Link to the ACOEM's "The Role of the Professional Supervisor in the Audiometric Testing Component of Hearing Conservation Programs" at:
http://www.acoem.org/guidelines.aspx?id=3050#

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Could similar damage occur in the human fetus? We don't know the answer to that question, but it is best to be cautious. The American Conference of Governmental Industrial Hygienists promulgated a recommended threshold limit value that called for pregnant women (beyond the fifth month of pregnancy) to avoid steady-state noise levels over 115 dBC and impulses over 155 dBC peak.

Steady-state levels of 115 dBC or greater are rare, so this is not a concern for most individuals. However, we do not know to what extent intense mechanical vibrations pass to the fetal inner ear, a situation that may occur if women are in physical contact with noisy equipment.

Pregnant women will need to be cautious when discharging firearms. Shooting weapons that are more powerful than a .22 caliber rifle or pistol should be discouraged. The muzzle blast of most firearms used for hunting exceeds 155 dBC peak and should be avoided. Moreover, we do not have good information about how the energy in the recoil of weapons is transmitted to the fetal head. Organizations and agencies that require employees to qualify each month on the target range may want to curtail the practice during a woman's pregnancy.

The simple message is that only extremely intense long-duration exposures, well over 100 dBC, will affect the hearing of the fetus and produce tissue damage to the inner ear. In the vast majority of cases, pregnant women do not need to be concerned about noise producing hearing loss in their unborn child. Engaging in activities such as recreation and maintaining a household will not adversely affect an unborn child, however there are some activities and work situations where caution is prudent. So, the best advice to pregnant women is to enjoy the experience without undue concern for the hearing of the unborn child, but avoid extremely noisy working conditions and shooting weapons. And yes, it is okay to play music for the fetus.

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Kenneth J. Gerhardt, PhD, is Associate Dean of the Graduate School and Professor of Audiology at the University of Florida in Gainesville, Florida. His research interests include the effects of noise on hearing and fetal auditory development. He has over 90 publications and has served as principal investigator on numerous federal and private grants. His doctorate is from Ohio State University and he has been at UF for 29 years. He can be reached at: gerhardt@ufl.edu.

UPCOMING OHC CERTIFICATION AND RECERTIFICATION COURSES* 2007

*The listed dates indicate day one of the scheduled classes; certification courses are 20 hours in length; recertification classes are 8 hours.

Current as of May 2007 (for a complete list of courses visit our website at www.caohc.org); for the most current list of courses contact the CAOHC office at 414/276-5338.

Begin Date	State	City	Course Director	Phone
07/09/2007	FL	Pensacola	Georgia Holmes	205-934-7178
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07/11/2007	IN	Indianapolis	James Jerome	317-652-6788
07/11/2007	NC	Morrisville	Thomas Cameron	919-657-7500
07/11/2007	NC	Greensboro	Cheryl Nadeau	336-834-8775
07/11/2007	WI	Brookfield	Edward Korabic	262-547-2227
07/12/2007	GA	Atlanta	Linda Moulin	770-475-2055
07/16/2007	KS	Overland Park	Tamara Thompson	913-375-4411
07/17/2007	MO	North Kansas City	Linda Ratliff-Hober	816-221-3230
07/18/2007	IL	Rockford	Charles Russell	815-964-5445
07/18/2007	NY	Albany	Timothy Swisher	412-367-8690
07/18/2007	TX	Houston	Johnny Sanders	281-492-8250
07/18/2007	TX	San Antonio	John Elmore	800-357-5759
07/18/2007	WA	Seattle	Gaye Chinn	206-764-3330
07/23/2007	LA	Kenner	Michael Seidemann	504-443-5670
07/24/2007	PA	Bethlehem	James Robertson	610-868-8606
07/25/2007	GA	Atlanta	Robert Rhodes	281-492-8250
07/25/2007	GA	Atlanta	Melette Meloy	678-363-9897
07/25/2007	MI	Detroit	John Elmore	800-357-5759
07/25/2007	OH	Dayton	Chris Pavlakos	937-436-1161
07/26/2007	PA	Kittanning	Douglas Callen	724-543-7068
07/27/2007	OH	Dayton	Chris Pavlakos	937-436-1161
08/01/2007	IA	Davenport	James Jerome	317-652-6788
08/02/2007	NC	Greensboro	Cheryl Nadeau	336-834-8775
08/06/2007	MS	Hattiesburg	Robert Rhodes	601-264-3545
08/08/2007	AL	Birmingham	Georgia Holmes	205-934-7178
08/08/2007	FL	Jacksonville	Nancy Green	904-880-1710
08/08/2007	GA	Atlanta	George Cook	336-834-8775

Begin Date	State	City	Course Director	Phone
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08/08/2007	OH	Cincinnati	Timothy Swisher	412-367-8690
08/09/2007	AL	Birmingham	Georgia Holmes	205-934-7178
08/09/2007	FL	Jacksonville	Nancy Green	904-880-1710
08/13/2007	FL	West Palm Beach	Herbert Greenberg	678-352-0312
08/13/2007	OR	Portland	Rodney Atack	503-614-8465
08/13/2007	PA	Philadelphia	James Robertson	215-936-9923
08/15/2007	CO	Greeley	Laurie Wells	970-593-6339
08/15/2007	MI	Detroit	Robert Rhodes	281-492-8250
08/15/2007	PA	Pittsburgh	Timothy Swisher	412-367-8690
08/16/2007	CO	Greeley	Deanna Meinke	970-351-1600
08/16/2007	NV	Las Vegas	John Elmore	800-357-5759
08/17/2007	CO	Greeley	Laurie Wells	970-593-6339
08/17/2007	NC	Morrisville	Thomas Cameron	919-657-7500
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25 Most Active Course Directors in 2006 Announced

The CAOHC Council is pleased to announce the twenty-five most active Course Directors for 2006. More than 2900 new and recertifying students were certified as Occupational Hearing Conservationists from these 25 instructors alone. This represents 64% of ALL the students who certified or recertified last year. Congratulations!

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