CAOHC®

UPDATE

The Newsletter of the Council for Accreditation in Occupational Hearing Conservation

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Chair's Message

by Susan Cooper Megerson, MA CCC-A
CAOHC Chair, Representative of the American Speech-Language-Hearing Association

For most OHCs, day-to-day hearing conservation responsibilities include such "people oriented" activities as conducting audiometric tests, fitting hearing protection, providing employee training on the hazardous effects of noise, and counseling workers on the importance of protecting their hearing on and off the job. On occasion, however, you will be called upon to provide input on matters affecting the sound environment of your employees. Although the person typically responsible for developing and implementing noise controls is usually trained as an engineer, industrial hygienist, or safety specialist, the OHC can serve as an important liaison between workers and the noise control specialist.

As a reminder, **sound is caused by pressure variations** in any "elastic" (or movable) medium, such as air, water, metal, etc. These pressure changes may be in the form of *vibration*, such as the ringing of a bell, or *turbulence*, such as the explosion of a gun. Sound travels through these vibrations and can be transmitted from one medium to another. Sound can be "controlled" by changing the source of the sound, altering the path by which sound is transmitted, or by isolating or protecting the receiver, such as through the use of hearing protection devices.

This issue of the UPDATE focuses on a few special applications in acoustics and noise design. COL Dick Danielson, PhD, provides a practical guideline for designing an audiometric testing environment *(see the article below)*. Former CAOHC Council representative and certified noise control engineer, Dennis Driscoll, details key information for designing alarms and warning signals in noise environments *(see page 2)*. Please share these articles with your plant engineers or safety design team for reference on future projects at your workplace.

And, for those who haven't given much thought to "acoustics" or "sound physics" since your last CAOHC class, take the following quiz to refresh. Enjoy this issue of the UPDATE!

A Sound Quiz

1. Sound can travel in air and water, but not in solids. (True or False?)
2. If the air molecules themselves do not move very far, what is it that does travel, sometimes long distances?_____
3. The aspect of sound that is perceived as pitch is called _____and is quantified in terms of cycles per second, or _____.
4. One tone that is twice the frequency of another is one octave higher. (True or False?)
5. The technical name for the aspect of sound that is perceived as loudness is _____, or sound pressure level, measured in this unit:_____.
6. What are three common and easily observed indications that noise levels may exceed safe levels? _____.

ANSWERS ON NEXT PAGE

Quiet Please! We're Trying to Work Here!

COL Richard W. Danielson, PhD CCC-A
CAOHC Representative of the Military Audiology Association

During audiometric testing, occupational hearing conservationists (OHCs), as well as the employees they test, may often question how background noise levels affect audiometric results. While it seems intuitively necessary to have a maximally "quiet" area when performing this type of medical surveillance, most OHCs are required to conduct audiometry under conditions which are far less than ideal. Ironically, noise levels heard in the audiometric booth are far lower than hazardous levels found in the shops where the at-risk worker is employed, but can be much more noticeable to the employee when asked to "listen carefully" during audiometry. This article is intended to help understand the effect of background noises on audiometry, summarize existing

continued on page 7

What's Inside?

CAOHC UPDATE

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Answers to Quiz on Page 1

1. False
2. The pressure wave
3. Frequency, Hertz, (Hz)
4. True
5. Amplitude or intensity, decibel (dB)
6. Temporary hearing loss, tinnitus (ringing in the ears), difficulty communicating at a distance of 3 feet or less.

Questions and answers compliments of the 3rd Edition of the *CAOHC HEARING CONSERVATION MANUAL.*

Acoustical Considerations for Effective Emergency Alarm Systems in an Industrial Setting

Part One

David C. Byrne, MS CCC-A, and Dennis P. Driscoll, PE
Associates in Acoustics, Inc., Evergreen, Colorado

Background - OSHA Regulations

Compliance with the OSHA regulations regarding Employee Emergency Response Plans (29 CFR 1910.38 and 1910.120) requires that an alarm system must be installed which complies with 29 CFR 1910.165 "Employee Alarm Systems." The alarm system is an integral part of proper emergency response training and procedures. In the alarm system regulation, the *General Requirements* section states "The employee alarm system shall provide warning for necessary emergency action as called for in the emergency action plan, or for reaction time for safe escape of employees from the workplace or the immediate work area, or both." Emergencies that may likely be encountered include fires, toxic chemical release, tornados, etc.

To fully comply with the OSHA regulations and ensure appropriate actions are taken in an emergency situation, several pieces of information must be conveyed to employees throughout the plant. As a minimum, the type and extent of the emergency condition, location of the emergency, and the weather conditions are required for effective emergency response actions. A voice alarm system is not absolutely necessary to meet the requirements of 29 CFR 1910.165, however, this type of system is best equipped to rapidly disseminate the necessary information to employees.

Warning Signal Detection

An alarm signal will not be audible unless the sound pressure level of the alarm is great enough to overcome the masking effect of the background noise. Research conducted during the development of criteria for audible warning signals has shown that the alarm signal should be at least 15 dB above the employee's effective threshold of audibility in noise, or "masked threshold." Some investigators in this field advocate an 18 dB signal-to-noise ratio for 100% detectability, especially while hearing protection is being worn. A range of 15 to 25 dB above masked threshold is considered to be most desirable.

An International Standard was issued in 1986 (ISO 7731) that defines criteria applicable to the recognition of auditory danger signals, especially for high ambient noise areas. Guidelines are given in this standard for sufficient audibility based on overall A-weighted sound level readings, octave-band analysis, or one-third octave-band measurements. Using the A-weighting scale, the signal should exceed the level of ambient noise by 15 dB or more. More accurate predictions can be made by obtaining octave or one-third octave-band sound levels and comparing these to the employee's masked threshold.

The masked threshold is the level of sound at which the alarm signal is just audible above the background noise, taking into account the hearing deficiencies of the listeners as well as the attenuation of hearing protectors. When using octave band analysis, the alarm signal must be at least 10 dB greater than the employee's masked threshold in one or more octave bands between 300 and 3,000 Hz. If one-third octave-band levels are used, the alarm signal must exceed the masked threshold by a minimum of 13 dB in one or more one-third octave-bands in the frequency range 300 to 3,000 Hz. Extensive testing of the alarm signal strength throughout the plant is conducted.

Another important consideration is that the sound level of the alarm signal should not be so intense as to

continued on page 9

When the Damage is Done

How to Protect Workers With Hearing Loss

by Adrienne Burke

Are hearing-impaired workers at greater risk of accident and injury on the job? Might not seem like a question for scientific investigation. But it is one of those addressed by a study published in the *Journal of the American Medical Association* (JAMA) in December, 1997.

You might say it's a no-brainer. A worker who can't hear sirens, horns, whistles or the shouts of coworkers warning of danger, is obviously at greater risk of getting hit by a forklift rounding a corner. Indeed, that's what the *JAMA* article authors found: "Workers with disabilities, especially sensory impairments, appear to have an elevated risk for occupational injury."

How often job accidents are attributable to a worker's hearing loss isn't known. The study was able to link only 3.5 percent of occupational injuries to "prior disabilities." But the study also associated work disabilities, including sensory impairments, with a 36-percent increased risk of occupational injury.

What you might not realize, however, and what makes the *JAMA* article timely, is that the number of workers suffering hearing loss is likely to increase in coming years.

Art provided by E-A-R/Aearo Company

Boomers in rockers, rockers with boom-boxes

Take a look at your workforce: Aging baby boomers--like it or not--are beginning to show signs of wear and tear, like hearing loss; and following them is a generation that has grown up in an increasingly noisy world.

To be sure, the workplace itself has become a safer place for fragile cochlea in recent decades. OSHA noise exposure regulations, engineering advances, and comfortable hearing protection have eliminated many hearing hazards of old. "If you look at hearing conservation efforts over the last 15 to 20 years, programs have progressively improved. At least among big industries, you don't have the kind of noise exposure now that you did then," says Paul Brownson, MD, an occupational health physician for Dow Agro Sciences, LLC, Indianapolis, Ind., and a member of the Noise and Hearing Conservation Committee of the American College of Occupational and Environmental Medicine.

But outside work, the public is on its own for protection. No agency regulates noise at NASCAR races or Rolling Stones concerts.

Presently hearing loss afflicts 10 percent of Americans. Statistics indicate employers might be facing hearing-impaired workers in near-epidemic proportions.

Aging is the most certain factor. According to experts, 25 percent of people exhibit significant hearing loss by the time they reach their 60s. Between 1990 and 2050, the number of people with hearing impairments will increase at a faster rate than the total US population, according to the Better Hearing Institute (www.betterhearing.org).

The problem won't necessarily end as baby boomers retire. Noise exposure among young people is a lesser studied, but potentially significant contributor. The Sight and Hearing Association in St.Paul, Minn., cites a recent study of hearing among students in one school district in which the incidence of hearing loss among eighth graders increased 400 percent over ten years.

Brownson says pre-placement tests he conducts of young workers now turn up higher incidence of hearing deficits than 30 years ago.

Once the damage is done

Of course, there's nothing you can do to reverse the effects of hearing damage.

But to prevent it from getting worse, safety pros can train workers to protect their hearing on and off the job. "It

continued on page 4

Our noisy lives

90 decibels has been determined to be the maximum safe level of noise exposure for unprotected ears over an eight-hour workday. AT 95 dB, the maximum safe exposure time is four hours. AT 100 dB, only two hours of exposure is safe. At 120 dB, hearing damage can occur after only 7.5 minutes. So how much have you been exposed to these loud sounds:

Lawn mower:	90 dB
Snowmobile:	100 dB
Car horn:	110 dB
Baby's cry:	115 dB
Rock concert:	115-120 dB
Farm machinery:	90-110 dB
Firearms:	125-140 dB
Stereo headphones:	105-110 dB

Source: Sight & Hearing Associates, St.Paul, MN

When the Damage is Done,

continued from page 3

would benefit employers to address non-work-related noise induced hearing loss with workers," says Alex Sanchez, MD, director of occupational medicine at the Nalle Clinic in Charlotte, NC. *(Editor's note: Dr. Sanchez is a representative of the American College of Occupational & Environmental Medicine on the CAOHC Council.)*

When Sanchez detects a shift in a worker's hearing, he sits down with the individual to figure out what caused it. More often than not, he says, the shift can be linked to an off-the-job exposure like hunting, power tool use, or attending NASCAR races or loud concerts, he says.

If the damage is already done, accommodations can be made to protect workers whose impairment makes them an increased safety risk. Authors of the *JAMA* study conclude that "further research in the design and evaluation of improved workplace accommodations for workers with disabilities like hearing loss is needed." (The *JAMA* authors also remind employers that the Americans with Disabilities Act requires employment decisions to be based "on an individualized assessment of the individual's present ability" to perform the job, not "merely because of elevated risk.")

What can you do now to accommodate workers whose hearing isn't what it used to be?

Merrie Healy, vice president of risk control consulting for international insurance broker Sedgwick of Minnesota, Inc., gives this advice:

- **Tie in all your alarm systems with visual cues.** For example, reverse warning signals on forklifts should be accompanied by flashing lights, as should other audible alarms, she says.
- **Consider the needs of hearing impaired workers when developing an emergency evacuation plan.** Plans should be made in advance for anyone who needs special assistance.
- **Adapt phones with adjustments for the hearing-impaired.**
- Train hearing-impaired workers to be aware of the increased risk and potential hazards.
- **Work with your human resources department to make accommodations under the Americans with Disabilities Act for hearing-impaired workers with special needs.**

(Editor's note: Ms.Healy is a representative for the National Safety Council on the CAOHC Council.)

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OHC Corner

Occupational Hearing Conservation in Review

Barbara Panhorst-Lassiter, EdD RN COHN-S
CAOHC Representative of the American Association of Occupational Health Nurses

Since this is my last *OHC Corner* column, our editor has asked me to review the significant changes in the noise standard during the past ten years. After 10 seconds of reflection, I could think of only one major alteration.

In 1991, an OSHA memorandum to regional administrators defined the point at which hearing loss becomes recordable on the OSHA Form 200. This entails the recording of work-related shifts in hearing of an average of 25 dB or more at 2000, 3000, and 4000 hertz in either ear on the OSHA 200 log in states that follow federal guidelines. (Age adjustments are not allowed in Oregon.)

States following more stringent state guidelines (CA, MI, TN, NC and SC) record on the OSHA 200 log work-related standard threshold shifts (STSs) when an average change in hearing occurs of 10 dB or more at 2000, 3000, and 4000 hertz in either ear. *(Washington state urges employers to record STSs; however, citations will only be issued to employers who fail to record 25 dB shifts.)*

As most everyone knows, the recordability requirements have caused confusion for occupational hearing conservationists (OHCs) and other hearing professionals. Since STSs of 10 dB don't have to be reported to OSHA in states following federal guidelines, a major concern is that STSs are not receiving appropriate follow-up and referral in these states. Two sets of baselines must be maintained by the employer in federal guideline states -- one for 25 dB shifts and one for 10 dB STSs.

There are new things on the horizon in occupational hearing conservation. Not the least of these is the proposed change in recordkeeping (when will it ever come?) that may eliminate some of the recordkeeping confusion. And, then again, it may give us a new set of guidelines and create even more bafflement.

FREQUENTLY ASKED QUESTIONS:

Ear Irrigation

Question: *When an employee has a wax impaction that appears to be affecting audiometric test results, is it okay for the OHC to use wax softening agents and irrigate the ear?*

Answer: How do you know what is behind the impaction? Could there be a hole in the ear drum that you can't see? Is other etiology occurring in the ear? I personally believe that unless you are specifically trained to perform ear irrigation, this is best left to a professional.

Who Pays for Wax Removal

Question: *If I send an employee out to have a wax impaction removed, does my company have to pay for this visit?*

Answer: This depends mostly on your company and its policies. Some employers believe it is worth the cost of an audiologist's or doctor's visit to have the wax removed to obtain a more accurate audiometric test. Other employers may consider an ear wax impaction to be non work-related and therefore ask the employee to turn the office visit in on the company group medical policy. You should know before you send someone out exactly what your company policy is so there is no question to the employee regarding who will pay for the visit.

When Does the Company Pay

Question: *When does my company have to pay for an audiologist's or doctor's visit related to our occupational hearing conservation program?*

Answer: Sometimes additional testing is necessary or hearing protectors cause or aggravate a medical pathology of the ear. If the employee is referred for a clinical audiological evaluation or an otologic examination the company pays.

If a medical pathology of the ear is unrelated to the use of hearing protectors, the employee must be informed of the need for an otological exam. Give the employee a copy of the audiometric test results, advise that an otologic exam is needed, and explain that since this is non-occupational the company will not pay for the visit but the bill may be turned in on the company group medical policy. Document in writing what you have said to the employee and have the employee co-sign this statement.

Proof of HCP Training

Question: *How can I prove to an OSHA inspector that my company has provided annual HCP training?*

Answer: Annual training may be provided in a variety of ways (e.g. One-on-one at the annual audiometric test, safety meetings, small group presentations, department gatherings, etc.). If you are providing training in conjunction with the annual audiogram, a checklist is convenient for covering the three areas of instruction. Have the worker sign and date the checklist after you have finished. In group training, the important thing is to document who attended, the subject presented, the presenter and his/her qualifications, and the date. An easy way to document group training is to pass a clipboard that contains the required information at the top. As a reminder, revise the training content periodically to maintain interest.

Record Maintenance

Question: *How long do I need to keep the records involved with my HCP?*

Answer: The Noise Standard (1910.95) tells us to maintain noise exposure measurement records for at least two years. All audiometric test records must be kept for the duration of

continued on page 6

Happy 25th Anniversary!

Profile: Former Council Member

The following "interview" article is based on written materials submitted by Paul Ostergaard, and a telephone conversation with Merrie L. Healy, UPDATE Editor

Mr. Ostergaard graduated from the Massachusetts Institute of Technology (MIT) with a Master's of Science degree. His employment history included the Carrier Corporation; Lewis Goodfriend & Associates; which became Goodfriend & Ostergaard & Associates; which progressed to Ostergaard & Associates! Ostergaard's career focus was acoustics consulting. He retired in 1993.

My Years with CAOHC

Paul B. Ostergaard, MS PE

My association with CAOHC began with my appointment as an American Industrial Hygiene Association (AIHA) representative to the Council in 1983. At that time, I was on the AIHA Noise Committee. In the early days of my work with the Council, I taught prospective Course Directors acoustical instrumentation. Course refinements were made over the years in response to questions asked at the end of each course, discussions with the students, and the evaluation of Course Director needs.

In 1987, I became Secretary; Vice Chair in 1988; and was honored by becoming CAOHC Council Chair in 1990. During my tenure, a change in the support services (to the present management company) was deemed necessary due to the increasing growth of CAOHC's certification and recertification of Occupational Hearing Conservationists and Course Directors throughout the world.

1993 photo

Paul B. Ostergaard, MS, PE

I think, and hope, my lasting contribution to CAOHC has been the use of long-range planning. When I was Chair, an outside facilitator was utilized to assist the Council with planning and dreaming where CAOHC should go. We created a Mission Statement, developed a focus, and established five-year goals. One idea that came out of that initiative was to make CAOHC the premier hearing conservation group in the universe!

Ostergaard reports that his affiliation with CAOHC helped his career because of the many networking opportunities. He noted that the greatest change he has seen in hearing conservation over the years includes a greater awareness of noise exposure. However, he expressed concern that there still is a lack of understanding of the significance of noise exposure due to its gradual impact on hearing loss. He believes there is still a lack of emphasis on noise control and cites societal issues such as loud music and the inability to carry on a conversation in a restaurant due to the excessive background noise levels!

He continues his involvement with hearing conservation as the current Chair of the Acoustical Society Foundation. Ostergaard challenges CAOHC to avoid "short term vision". In other words, while immediate issues need attention, CAOHC should continue to envision "long term" in order to continue to make CAOHC the "premier hearing conservation group"!

The current CAOHC Council and staff wish to express appreciation to Paul Ostergaard for his years of participation and leadership in occupational hearing conservation!

OHC Corner,

continued from page 5

employment and the recordkeeping standard says employment plus 30 years. So, essentially audiometric test records are kept forever. Patient or client medical records that document follow-up and referral would also fall into the "forever" category.

Since OSHA inspectors frequently ask for the past five years, I suggest maintaining OSHA 200 logs, test room measurements, training, calibration, noise exposure and other HCP records a minimum of five years. It is advisable to keep these records together in one place such as a file or 3-ring binder. It sure helps to be organized if you are audited.

Farewell

It has been a pleasure to serve as Chair of the OHC Committee. This is your column! Keep your questions coming into the committee by contacting the CAOHC Executive Office (see masthead on page 2 for mailing address, phone number, fax number or e-mail). It is not necessary to sign inquiries unless you want a personal response.

CAOHC Council to Meet In Chicago, Illinois

The Council will conduct their semi-annual Council meeting on Tuesday, October 6, 1998 at the Sheraton Gateway Suites in Chicago, Illinois. The Council continues work on the goals and projects of CAOHC as well as the assessment of future needs for occupational hearing health.

Quiet Please! We're Trying to Work Here!

continued from page 1

standards and offer some recommendations for reducing their impact on the hearing conservation program.

When noise levels in the testing environment are high, the OHC may see elevated thresholds at 500 Hz (and, sometimes at 1000 Hz) due to the effect of masking or interference with the test stimuli. If the primary purpose of the audiometry is to produce a baseline test, such false elevations may result in unnecessary medical referrals by the reviewer of the test results. Moreover, such invalid baseline results will complicate all subsequent comparisons in periodic audiometry (or possibly, a compensation case). At the very least, even relatively little background noise (from a murmured voice, a humming computer, or a cabinet door's click) can distract the employee during testing and cause them to question the validity or quality of the testing services (and recommendations) provided by the OHC. This is especially true if the results are reported to be not within normal limits. Higher frequencies, however, are not as well masked by room noise (test it yourself-check your own hearing thresholds while a radio is playing and then test again with the radio off.) An audiogram that is normal in the low frequencies, but then drops to a classic notch at 4000 Hz, is more likely really related to the employee's years of exposure to machinery noise than to a 1-second cough heard through the booth walls.

It is important for the OHC to know the standards for maximum allowable sound pressure levels in the test room and minimize all unnecessary noises. Rooms used for hearing conservation audiometric testing, whether they are audiometric booths or a nurse's office, should not have background noise levels that exceed CFR 1910.95 (see table below) when measured by equipment conforming to at least Type 2 ANSI specifications for sound level meters. In addition, sound level meters must have an octave band filter which allows measurement of sound pressure level. (Note that the maximum allowable levels in hearing conservation programs are much less stringent than required by ANSI in clinical audiology booths). If you do not have such measuring equipment, contact an industrial hygienist, audiologist, or acoustical engineer. Room measurements should be taken during typical activities of the day (e.g., when the staff is conducting business, not before people come to work in the morning.) Measure and record the levels in the location where the employee's head will be during audiometry (and if a multi-person booth, at each testing station) and compare to the standards. It is important to be aware of any operational changes in the environment that occur after you've made your first measurements. Be vigilantly aware of new traffic flow patterns or activity levels in the area, which can alter the noise in your testing area.

Maximum Allowable Octave Band Sound Pressure Levels For Hearing Conservation Audiometric Rooms

Octave (Hz)	500	1000	2000	4000	8000
SPL (dB)	40	40	47	57	62

What are the most likely causes of noise problems? Obviously, the level of activity outside the booth can create a noise signature. These booths are NOT "sound proof", but sound treated, in that they attenuate sound levels, rather than block all sound. Once again, low frequencies are more relevant, since acoustic impedances related to the mass of the booth's walls (and the exterior room's walls) attenuate higher frequencies better than low frequencies. (Think of apartments you've lived in - you cannot hear your neighbor's cuckoo clock, but the bass of their stereo booms loudly.) Consequently, the OHC should exercise strict control over the activity on the exterior side of the booth, especially if there is no separate waiting area. A useful option to consider is to install one of the instruments capable of constantly monitoring noise levels within the booth. When this instrument senses intermittent noise levels that exceed standards, it will give a visual alert to the tester, who can then pause all audiometric testing until the situation is resolved and levels are within acceptable limits. If such equipment is in place and used on an ongoing basis, the OHC and program manager can better defend unsubstantiated challenges from employees or management that "it was too noisy" during the session.

When an audiometric booth is used, mechanical problems in the ventilating fan and deteriorating door seals can occur gradually over time and the OHC may not realize that noise levels have increased. Fortunately, these problems can be overcome with fairly routine maintenance (e.g., attention to the fan and replacement of the seal) by knowledgeable personnel. It is especially important that trained personnel be involved in any movement of an audiometric booth from one location to another. While it may seem to be a simple matter of mechanics and brute strength to take a booth apart and move it to a new clinic, for example, the results can be disastrous if the adjoining edges or panels are damaged or warped. Good advice (from one who's been there) is to first avoid moving any installed booth by asking management to reconsider their "new office plan"...then, if necessary, hire a qualified expert!

If you are lucky enough to buy a new installed booth, think carefully when planning installation. You should work closely with a trusted vendor as you consider traffic flow and where to place the booth in the room. Don't choose a room with inherent noise problems because it's already too close

continued on page 8

Upper Limits On Noise In The Workplace

by Stephen I. Roth, PE
CAOHC Representative of the Institute of Noise Control Engineering

Do you want to better understand why 85 dBA is the acceptable industrial noise level throughout most of the world? Or why the 3 dB exchange rate is preferred in just about every country except the United States? If so, get a copy of the December 1997 report from The International Institute of Noise Control titled "Technical Assessment On Noise In the Workplace". (See below)

The report briefly reviews the scientific and epidemiological evidence relating exposure to noise, including impulsive noise and risk of hearing damage, and discusses the factors that are relevant to legislation.

A working party of members from Australia, Brazil, Canada, France, Germany, Hungary, New Zealand, and the United States developed the recommendations which included the following:

- It is desirable for jurisdictions without regulations, or with currently higher limits, to set a limit on noise of an average of 85 dB(A) over an eight hour exposure.
- The regulations should set a limit of 140 dB for C-weighted peak sound pressure level.
- An exchange rate of 3 dB per doubling or halving of exposure should be used. (Editor's note: The United States uses a more lenient 5 dB exchange rate in its OSHA Regulation.)
- Efforts should be made to reduce levels of noise in the workplace to the lowest economically and technologically reasonable values, even when there may be no risk of long term damage to hearing.
- At the design state of any new installation, consideration should be given to sound and vibration control.
- The purchase specifications for all new and replacement machinery should contain clauses specifying maximum noise levels.
- A long term noise control program should be established and implemented at each workplace where the level of noise exceeds 85 dBA on an eight hour time weighted average.
- The use of personal hearing protection should be encouraged when engineering controls do not reduce noise below 85 dB(A) on an eight hour time weighted average.

Contact the International Institute of Noise Control Engineering at:
PO Box 3206, Arlington Branch
Poughkeepsie, NY 12603
Voice: 914/462-4006
Fax: 914/463-0201
e-mail: manager@ince.org

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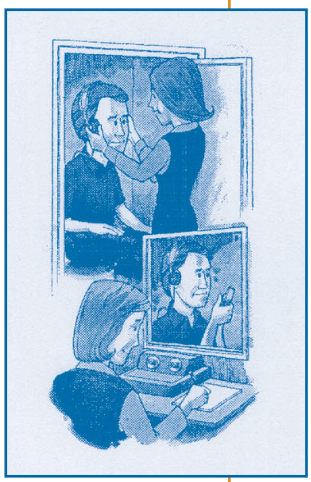
continued from page 7

to a waiting area, intercom, bathroom (with water pipe and commode noise), or coffee break area. Measure sound pressure levels (in octave bands) prior to ordering the booth and consider the worst case scenario. Your vendor's consultant will help you determine whether you can meet acceptable levels with the proposed booth or recommend another alternative, like a double-walled booth. Plan your booth with a door that will not swing abruptly into a wall or your equipment, nor force you and your employees to walk around its wide swing (such booths do not have reversible doors like refrigerators). If you must test in multiple locations and need a booth, some smaller, "portable" booths are available that weigh 600 pounds or so and can be transported on casters. Employees will find that the limited space inside such booths can be somewhat cramped and the thinner walls attenuate less, but such booths have an advantage if you are now forced to test in unsatisfactory plant offices and when mobility is required. If you are really mobile and have a testing van, consider your parking location, generator's location and maintenance, and where you place the waiting area for employees standing in line for audiometry.



Art provided by E-A-R/Aearo Company

Noise-reducing earphone enclosures should not be used in lieu of sound-attenuating audiometric booths. These devices enclose standard earphones within exterior cups and foam, but are not effective in reducing the low frequency noise, which interferes with audiometry, and are relatively heavy, bulky and uncomfortable to wear. Insert phones (which route the stimuli through foam earplugs) are far better at attenuating low frequency noise levels, but obviously increase costs related to the disposable plus and, when used in hearing conservation pro-grams, require complicated documentation of the conversion of outputs from conventional earphones to these insert phones. In addition there is evidence that OSHA may cite employers for use of insert earphones due to adherence to older calibration! (See Fed. Regs 1910.95)

While background noise levels in audiometric testing environments present some dilemmas to OHCs and hearing conservation, these problems can be overcome with a reasonable amount of careful monitoring and some maintenance in most situations. Since audiometric booth enclosures are a key part of this process, OHCs and program managers should carefully consider their needs and resources when starting or modifying a new program.

Acoustical Considerations

continued from page 2

cause undue startle, which is possible when the level increases more than 30 dB in 0.5 seconds. Further, it is easier to hear the alarm signal if the frequency where the background noise is loudest is different than the frequency where the output of the signaling device is highest. The alarm signal should be based on the 300 to 3,000 Hz frequency range, with sufficient energy below 1,500 Hz to meet the needs of individuals with hearing loss, or employees wearing hearing protection.

Temporal characteristics of the alarm signal are also discussed in the ISO Standard. Pulsating signals are preferred over signals that are constant in time. A repetition frequency range of 0.2 to 5 Hz is specified; however, the pulse duration and repetition frequency must not be identical to any fluctuating ambient noise source in the surrounding area. The frequency (pitch) of the signal may also be varied, instead of using a single continuous tone.

Factors Influencing the Intelligibility of Speech Messages

The acoustic qualities of speech are characterized by strong vowel sounds in the low frequency range (500 Hz and below), and relatively weaker consonant sounds in the higher frequencies. Despite their lower overall intensity, the high frequency consonant sounds contribute most to speech intelligibility. Fortunately, spoken language contains built-in redundancy, which makes a sentence understandable even when a particular word is not correctly recognized. Grammatical structure, sentence length, context, and listener familiarity with the speech material contribute to understanding a message in less than optimal listening conditions. This redundancy is extremely beneficial when high background noise levels exist and hearing protectors are worn.

High frequency speech sounds are most readily affected during transmission through standard communication systems, which typically have poorer reproduction capabilities above 3,000 Hz. In industrial settings, low frequency sounds tend to mask or obscure mid- and high frequency sounds, which leads to decreased speech intelligibility. The combination of a degraded speech signal and high background noise levels result in a greater loss of speech recognition ability than otherwise would be expected.

Speech intelligibility can be predicted or quantified by a variety of methods. The Articulation Index (ANSI S3.5-1969 R1986) is a popular and highly respected measurement tool used to predict speech intelligibility in noisy conditions. The Articulation Index (AI) is a numeric value between zero and one that represents the effective proportion of the normal speech signal that is available to a listener (i.e., 0% to 100%). Acoustical measurements of the speech signal and background noise are used to compute the AI for a particular listening situation.

As the Articulation Index increases from zero to one, the percentage of correctly understood test items increases, although at a different rate, depending on the type of test material. A test vocabulary of 32 single words yields 100% intelligibility at an AI value of 0.4, while a test comprised of 1000 unexpected words or nonsense syllables requires much more information (i.e., a higher signal-to-noise ratio or higher AI value) to achieve even 90% recognition. Curves with steep slopes indicate that the expected intelligibility reaches a maximum more quickly, meaning that the speech material may be understood more easily.

As discussed earlier, the redundancy of connected speech (i.e., sentences) and potential familiarity with the content of the message will aid in its intelligibility. The intelligibility of a typical public address system would be closely approximated by the curve corresponding to sentences being presented to listeners for the first time. Therefore, a high degree of intelligibility can be expected for AI values above 0.4. Unfortunately, there is no single AI value that can be specified as a criterion for "acceptable" communication. ANSI S3.5 indicates that commercial communication systems generally provide AIs above 0.5, while an AI of 0.7 or higher appears appropriate for communication systems used under a variety of stress conditions and by a large number of different talkers and listeners.

Research has been conducted to investigate the relationship between different methods of estimating speech intelligibility. As indicated above, the Articulation Index is commonly used since it typically shows the least variability in predictive capability. However, the AI can be somewhat complicated to use in terms of measurement and calculation. A-weighted sound level readings can be used to estimate AI values by measuring both speech and noise levels to obtain a speech-to-noise ratio. An AI score of 1.0 (100% of the speech information available to the listener) corresponds approximately to an 18 dBA speech-to-noise ratio, and a 15 dBA speech-to-noise ratio will achieve an AI of approximately 0.9.

Plant Ambient Noise Environment

Noise levels should be measured throughout the plant to assess the acoustical environment in which the warning/notification system must operate. Sound level survey results may be displayed graphically on plant layout drawings, to aid in determining required system coverage for the entire plant. Additionally, correct speaker selection and placement can be achieved by supplementing the overall sound level readings with one-third octave-band measurements. These measurements are used to separate the noise signal spectrum into distinct frequency bands one-third of an octave in width, enabling a better characterization of the type of background noise present.

To be continued in Winter '98 Update

Course Director Workshops

Fall 1998: Preceding the Council meeting, a Course Director Workshop will be held on Monday, October 5, 1998 at the Sheraton Gateway in Chicago. Attendees will be able to identify course requirements and procedures related to certification of occupational hearing conservationists.

Spring 1999: The Spring 1999 Course Director workshop has been scheduled for Friday, April 16, 1999 at the Hyatt Regency DFW in Dallas, Texas.

Please access our website at *www.caohc.org* or call the Executive office at 414/276-5338 if you are interested in certifying as a CAOHC Course Director, or if you are a Course Director needing to recertify through the workshop method.

CAOHC Website Domain

You can now find CAOHC under the new address: **http://www.caohc.org.** The old site address will reference the new domain.

CAOHC's e-mail address has changed to: **info@caohc.org**

Hearing Conservation Manual, 3rd Edition

About the Manual . . .

The manual has been completely rewritten, revised and updated with additional information on the OHC's mission, training, and role, and includes a separate chapter on federal and state regulations. This revised version also has more detailed chapters on audiometric equipment and procedures for audiometric testings, plus the sections on sound and noise measurement are more "reader friendly." All of the information on instruments, procedures, and regulations is current, including the appendices that contain new checklists and samples of forms used by experienced hearing conservationists.

About the Author . . .

Alice Suter, PhD has been extremely influential in noise criteria development, regulation, and public policy, first at the Environmental Protection Agency's Office of Noise Abatement, and later at OSHA. As Senior Scientist and Manager of the Noise Standard at OSHA, she was principal author of the Hearing Conservation Amendment. She is now a consultant in industrial audiology and community noise. Among her clients have been the World Health Organization, the Administrative Conference of the U.S., and various private companies, individuals, citizens groups, and government agencies on the federal, state, and local level.

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Upcoming OHC Certification and Recertification Courses*

Approved August 1998

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

Date	City	Course Director	Phone
9/14	Philadelphia, PA	Klavans, Sharon	(Navy) R
9/15	Greensboro, NC	Juarez, Omar	910/665-1818
9/15	Liberty, MO	Ratliff, Linda	816/781-9268
9/16	Los Angeles, CA	McCall, Kirsten	310/605-1466 (NR)
9/16	Atlanta, GA	Elmore, John	800/357-5759
9/16	Atlanta, GA	Moore, A. Gregg	(Private)
9/16	Cleveland, OH	Wolfe, William	770/475-2055
9/16	Portland, OR	Fairchild, Michael	503/232-1646
9/16	Cleveland, OH	Snyderwine, Carol	216/692-7466
9/16	Albany, NY	Swisher, Timothy	412/367-8690
9/16	Portland, ME	Hengen, Dr. C.Garth	508/752-4663
9/16	Pulaski, TN	Russell, Charles	770/754-4415
9/17	Pittsburgh, PA	Angelelli, Roger	412/831-0430
9/21	Lexington, KY	Green, Dr. William	606/323-5840
9/22	Concord, NH	Gordon, Pamela	781/891-9124
9/22	Marietta, GA	Moore, A. Gregg	770/953-4699
9/22	Salt Lake City, UT	Deppensmith, Kathryn	713/869-6664
9/22	Hillside, IL	Stukas, Natalie	630/241-0990
9/22	Mandeville, LA	Istre, Dr.Clifton	318/233-4081
9/22	Syracuse, NY	Cook, George	336/665-1818
9/23	Dallas, TX	Harris, Dr. Dean	970/586-0702
9/23	Chapel Hill, NC	Stewart, Andrew	800/334-5478 (NR)
9/23	San Antonio, TX	Elmore, John	800/357-5759
9/23	Saginaw, MI	Kowalski, Richard	517/757-4379
9/23	Cincinnati, OH	Swisher, Timothy	412/367-8690
9/23	Portland, OR	Dolan, Dr. Thomas	503/725-3264
9/23	Piscataway, NJ	Kelly, Ellen	732/238-1664
9/23	Richland, WA	Turner, Jay	509/735-7461
9/24	Newport News, VA	Hecker, Henry	757/874-4665
9/24	San Diego, CA	Sandlin, Dr. Robert	619/229-0722
9/28	Syracuse, NY	Oviatt, Dr. Dana	315/428-0016
9/28	Scranton, PA	Rhodes, Robert	713/869-6664
9/28	Washington, DC	Bowling, Lloyd	301/934-4130
9/29	Los Angeles, CA	Chiarello, Joseph	610/667-1711
9/30	Calgary, ALB	Moore, Thomas	403/264-1130
9/30	Little Rock, AR	Rimmer, Thomas	501/663-4742
9/30	Lansdale, PA	Reiff, Patricia	215/855-4217
10/1	Destin, FL	Meloy, Melette	205/444-9797
10/5	Portland, OR	Atack, Dr. Rodney	503/614-8465
10/5	Rochester, NY	Rhodes, Robert	713/869-6664
10/5	Elicott City, MD	Moreland, Rebecca	410/646-2121
10/6	Lancaster, PA	Thompson, Tami	816/471-3900
10/6	Erie, PA	Nutter, Dr. James	814/453-4716
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10/7	Valley Forge, PA	Swisher, Timothy	412/367-8690
10/7	Indianapolis, IN	Lyon, Melissa	765/662-1702
10/12	Des Moines, IA	Elmore, John	800/357-5759
10/12	Mobile, AL	Rhodes, Robert	713/869-6664
10/12	Phoenix, AZ	Deppensmith, Kathryn	713/869-6664
10/12	Kansas City, MO	Ratliff, Linda	816/482-5470
10/13	Los Angeles, CA	McCall, Kirsten	310/605-1466
10/13	Detroit, MI	Simpson, Dr. Thomas	313/577-6754
10/14	Brookfield, WI	Korabic, Dr. Edward	414/288-3428
10/15	Cleveland, OH	Rhodes, Robert	713/869-6664
10/19	Austin, TX	Elmore, John	800/357-5759
10/19	Shreveport, LA	Rhodes, Robert	713/869-6664
10/20	Charlotte, NC	Newman, Valerie	800/334-5478
10/20	Woburn, MA	Gordon, Pamela	781/891-9124
10/20	Oakbrook Terrace, IL	Thunder, Thomas	847/359-1068
10/20	Atlanta, GA	Chiarello, Joseph	610/667-1711
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10/21	Charlotte, NC	Newman, Valerie	800/334-5478
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10/26	St.Louis, MO	Rhodes, Robert	713/869-6664
10/26	Bremerton, WA	Young, Jeffrey	(Navy)
10/27	Beaufort, SC	Faulkner Gischia, Carole	(Navy)
10/28	Omaha, NE	Norris, Dr. Thomas	402/391-3982
10/28	Birmingham, AL	Meloy, Melette	205/444-9797
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11/2	Liberty, MO	Ratliff, Linda	816/781-9268
11/3	Wellesley, MA	Gordon, Pamela	781/891-9124
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