

Can You Hear Me Now? Articulating Noise Assessments and Hearing Loss

**Kristin Bota, CSP
Chubb and Son, Inc.
Dallas, TX**

**Michael Ruddy, CSP
Chubb and Son, Inc
Indianapolis, IN**

**Louise Vallee, CSP, CIH, CPE
Chubb and Son, Inc
Whitehouse Station, NJ**

Introduction

Noise has been recognized as an occupational hazard since the 1700's. Noise is considered unwanted sound and is a by-product of many industrial operations. Sound results from pressure changes in air due to vibration. Overexposure to noise results in hearing loss. The extent of hearing loss depends upon loudness and duration of exposure. Noise-induced hearing loss can start out as a temporary effect from short-term exposure and recovery occurs after removal from exposure. This effect is experienced by many people after attending a loud concert. This reversible effect is called a Temporary Threshold Shift (TST). Repeated and chronic overexposure to noise can result in permanent hearing loss, called a Permanent Threshold Shift (PTS).

Occupational hearing loss results in difficulty in hearing and communicating with coworkers, family members and the general public and feelings of isolation. In the workplace it causes reduced safety awareness and accidents, lack of perception of forklifts and warning alarms, and reduced productivity. Tinnitus, ringing in the ears, can also be experienced.

OSHA estimates that 30 million American employees are exposed to excessive workplace noise. Noise assessments are the most common industrial hygiene consultation conducted. It is widely acknowledged that noise-induced hearing loss can be reduced or eliminated through hearing conservation programs and engineering controls. Interestingly, the incidence of OSHA 300 hearing loss recordable cases is decreasing while workers' compensation claims are increasing. These scenarios are due to more stringent reporting requirements and earlier problem recognition. A 2005 University of Washington study found that most of the participating

companies had substantial shortcomings in their hearing loss prevention programs.¹ Lack of exposure monitoring, hearing protection enforcement and audiometric test follow-up result in potential hearing loss being addressed less effectively than possible.

Beginning January 1, 2003, employers must record workers with an average hearing loss of 10 dB at 2000, 3000, and 4000 hertz and whose hearing level threshold after the change averages 25 dB or more at 2000, 3000, and 4000 hertz on the OSHA 300 hearing loss column. Before that time hearing loss was recorded when there was an average loss of 25 decibels at 2000, 3000, and 4,000 hertz (Hz). With recognized hearing loss, the employer must take protective measures, including requiring the use of hearing protectors for affected employees.

The Bureau of Labor Statistics recordable hearing loss reduction trend follows the timeline of more stringent reporting requirements. See Table 1. There has been a clear reduction in recordable cases over the past four years from the manufacturing sector.

Table 1. Occupational Noise Statistics

BLS Hearing Loss Data – Recordable Cases²

Category / Year	2004	2005	2006	2007
Total Private Industry	28,400	26,900	24,400	23,000
- Goods, Producing	24,300	22,900	20,000	19,400
- Services	4,100	4,100	3,600	3,700

Because noise is a common industrial exposure, there are a significant number of OSHA citations for noncompliance with 1910.95 each year. See Table 2. This standard is the twelfth most frequently cited OSHA standard for the manufacturing sector. One example of an OSHA citation is a company that was fined \$89,750 for failure to protect workers against occupational noise hazards (\$63,000 for failure to provide required medical evaluations; \$24,750 for failure to maintain and monitor a hearing conservation program and \$2,000 for failure to meet recordkeeping requirements).³ These penalties can be significant but pale in comparison to the cost of work-related hearing loss illnesses.

¹ Daniell, William et al, Occupational Hearing Loss in Washington State, CDC/NIOSH 5 R01 OH 03894-03, January 10, 2005, p. viii

² Bureau of Labor Statistics (BLS). Industry Injury and Illness Data – Table SNR07 2004 – 2007 (<http://www.bls.gov/iif/oshsum.htm>)

³ Smith, S. “OSHA: Employer Failed to Protect Workers from Occupational Noise” EHS Today. June 12, 2002 (http://www.ehstoday.com/news/ehs_imp_35541/index.html).

Table 2. OSHA Noise Related Citations – October 2007 – September 2008 ⁴

Industry	OSHA Std.	No. Inspections	No. Citations	Penalty
Manufacturing	1910.95	381	794	\$578,188
Construction	1926.52	18	25	\$ 21,500

Hearing Loss and Compensability

In some cases, earlier hearing loss identification has resulted in an increased occurrence of workers' compensation hearing loss claims. In the United States, different states have different hearing loss thresholds for workers' compensation partial and total disability, as well as positions on workplace causation or aggravation of pre-existing conditions. A Standard Threshold Shift does not automatically document the basis for a Workers' Compensation claim. Each state has developed compensability laws and requirements. Some states require that workplace noise levels exceed 90 dB(A). All noise surveys should be carefully completed to accurately represent employee exposure because at a future point past survey data may be requested as part of a compensability evaluation.

Baseline audiograms are important to establish initial employee hearing thresholds upon job entry. Companies with high turnover sometimes have difficulty keeping up with baseline audiograms and run the risk of hiring an employee with an unrecognized pre-existing hearing loss condition.

In the case of compensable hearing loss, workers' compensation benefit levels are determined by the individual states and can vary dramatically. For the total loss of hearing in one ear, benefits levels can range from \$5,520 in California to \$101,502 in Oregon. For cases involving the total loss of hearing in both ears, the benefit levels range from \$35,860 in Alabama to \$250,985 in Illinois.⁵ The definitions as to 'total hearing loss' or 'occupational deafness' and the varying degrees of hearing loss also can vary as differing criteria are applied at the state level. These aspects directly impact the threshold at which work-related hearing loss is determined to be compensable. Often American Medical Association (AMA) criteria are utilized but this is not uniformly the case. Even when AMA criteria are utilized, the version applied may be the third edition to the fifth version while some states simply apply the latest version.

Previous employment, noisy leisure activities, and aging may also impact hearing ability. The National Academy of Science's Institute of Medicine released a 2005 study highlighting war veteran hearing loss.⁶ Gun sports, motorcycles, and racing have been associated with the potential for hearing loss as well as the use of personal music electronics. Presbycusis references gradual

⁴ Occupational Safety and Health Administration (OSHA). Frequently Cited OSHA Standards for Manufacturing and Construction (<http://www.osha.gov/pls/imis/citedstandard.html>)

⁵ U.S. Chamber of Commerce – Research and Analysis Center, "Analysis of Workers' Compensation Laws" 2008.

⁶ Humes, Larry, et al, Noise and Military Service:: "Implications for Hearing Loss and Tinnitus," National Academies Text, Washington, DC, 2005.

hearing loss due to aging. Presbycusis is taken into account by most states, but is excluded in at least 13 states.

The number of workers' compensation hearing loss claims in Washington State increased twelve fold between 1984 and 1998 due to a new two year window restriction on the filing of hearing loss claims post initial diagnosis.⁷ Many of these claims were from workers older than 65 years.

There has not been a high incidence of fraudulent hearing loss claims which account for less than .5% of all workers' compensation claims. Inconsistencies in noise measurements and hearing tests are observable discrepancies. Audiograms display a characteristic work induced hearing loss dip at 4000 Hertz. New Zealand has experienced a six fold surge in hearing loss claims seven years ago due to solicitation of potential cases by two organizations, worsened by the lack of a minimum hearing loss threshold.⁸ A delivery driver strike at two U. S. newspaper plants was followed by the filing of a rash of hearing loss claims. Subsequent noise level testing identified mid 70 decibel levels at the truck loading areas where drivers spent two hours each day. Follow up audiometric testing did not match initial tests. Additionally many drivers had recently renewed their commercial license test and successfully passed audiometric testing. The employer filed a civil action under the Racketeering in Corrupt Organizations (RICO) law against the employees, their attorneys, and the physician who examined them.⁹

Retesting is an important step in hearing loss validation, followed by medical evaluation for other causes, retraining and hearing protection fitting. These practices are recommended by the Council for Accreditation in Occupational Hearing Conservation. The CAOHC provides education and guidance to industry and hearing conservation practitioners and technicians regarding the successful implementation of an occupational hearing conservation programs. CAOHC certifies Occupational Hearing Conservationists who may conduct audiometric testing but not interpret results.¹⁰ According to CAOHC's definition, a certified occupational hearing conservationist or audiometric technician "is a person who can conduct the practice of hearing conservation, including a pure-tone air conduction hearing evaluation and other associated duties under appropriate supervision, and who can function with other members of the occupational hearing conservation program team. Certification of OHCs...

- Better defines the criteria for professional recognition.
- Identifies the body of knowledge and the work experience needed to qualify as a certified occupational hearing conservationist for industry and mining.

⁷ Daniell, William et al, "Increased Reporting of Occupational Hearing Loss: Workers' Compensation in Washington State 1984 – 1998, American Journal of Industrial Medicine, Volume 42, Issue 6, 2002, Wiley Interscience, p.502

⁸ "1.7 Industrial Deafness Alert 5,"Scrutiny of Acts and Regulations Committee, Parliament of Victoria http://www.parliament.vic.gov.au/sarc/Alert_Digests_94/alert5b.htm

⁹ Erdrich, John, "Analysis of Audiometric Database Shows Evidence of Employee Fraud," Acoustical Society of America Journal, Volume 114, Issue 4, pp. 2373-2374, 2003

¹⁰ Rabinowitz, Peter, MD, MPH, "Determining When Hearing Loss is Work Related," CAOHC Update, Fall 2005

- Stimulates and encourages the professional development of all individuals in the field.
- Measures the candidate's knowledge and ability with respect to the current state of the art.
- Provides personal satisfaction with recognition of competency among a professional group.
- Benefits the hearing health of occupationally noise-exposed work”¹¹

Noise Monitoring

Initial noise monitoring efforts are conducted to identify employees exposed to noise levels greater than an 8 hour shift Action Level of 85dB(A) for hearing conservation program inclusion. Average noise level measurement for shift exposures above 90 dB(A) are key for provision of appropriate hearing protection attenuation and engineering control efforts. The Action Level for 10 and 12 hour shifts are reduced to 83 dB(A) and 82 dB(A) respectively based on Table G-16A of 1910.95. OSHA’s current policy is not to reduce PELs for extended shifts. OSHA specifies that employee exposure to impulsive or impact noise not exceed 140 dB(A). American Conference of Governmental Industrial Hygienists Noise Threshold Limit Values, National Institute of Occupational Safety and Health Recommended Exposure Limits, and many European standards are more conservative than OSHA providing an 85 dB(A) 8 hour exposure limit and three decibel doubling rate. OSHA adopted the current 85 dB(A) Action Level due to concerns for potential hearing loss between 85 and 90 dB(A).

NIOSH Hearing Impairment Research Estimates (1 – 2 – 3 – 4 K Hz)¹²

40 Year Working Lifespan	% Exposed Population
Exposures up to 90 dBA	25%
Exposures up to 85 dB(A)	8%
Exposures up to 80 dB(A)	1%

Representative monitoring should be completed to accurately assess employees exposed above and below the Action Level. Employees overexposed to noise and not identified during monitoring efforts will be subject to potential hearing loss. Some companies conservatively choose to include peripheral employees just outside noisy areas in hearing conservation programs, while others seek to eliminate unnecessary expense and oversight.

Noise monitoring must include all continuous, intermittent, and impulsive noise within an 80 dB to 130 dB range and be completed on a typical work day. Area or personal monitoring may be accomplished, with personal monitoring best for variable noise exposure. Typical noise monitoring equipment includes sound level meters, noise dosimeters, impact noise monitors, and

¹¹ CAOHC, <http://www.caohc.org/ohc/ohccertified.php>

¹² National Institute of Occupational Safety and Health, “Criteria for a Recommended Standard: Occupational Noise Exposure,” Publication 98-126, 1998

octave band analyzers. OSHA specifies that sound level meters and noise dosimeters use a 5 decibel exchange rate and minimally meet ANSI Type 2 standards with an accuracy of + or – 2 decibels. Type 1 meters are preferred for noise control work.¹³

Sound level meters are best used for measurements of continuous noise with little variation, like printing presses. Noise dosimeters are typically used to monitor variable noise which is automatically integrated into a time weighted average measurement. Most current noise dosimeters have a sound level meter function and can log data over time, providing a variety of final measurements which assist in analysis of noise problems. Impulse or impact noise response meters or filters are designed for peak and integrated impulse measurements. Octave band analyzers are most often used for noise control applications.

It is well worth taking time in advance of noise surveys to become familiar with equipment and features. Best efforts in the past have been foiled by not depressing the “run” mode button or securing the display on noise dosimeters. Noise equipment must be properly positioned in the hearing zone which is defined by OSHA as within a 1 foot radius sphere around the worker’s head. Manufacturers’ instructions for sound level meter microphone positioning should be followed. Perpendicular incidence microphones are pointed at the noise source and parallel to the ground. Positioning the meter away from the body reduces noise field interference.¹⁴ Noise dosimeters with cabled microphones are affixed to the worker’s belt or pants waist via a clip. Microphone cables typically cross upwards across the back with the microphone clipped to a shirt collar. New small cable-less designs clip directly to the shirt collar.

If little knowledge exists relative to noise exposures at the facility and operations to be monitored, a pre-survey should be conducted. This visit provides an opportunity to identify noisy areas and employees. A small floor plan will assist in charting positions and areas monitored, as well as initial sound level measurements. The “rule of thumb” with noise pre-assessments is that if one has to “speak up” to be heard during a conversation, a need exists for noise monitoring and OSHA compliance evaluation.

Calibration and battery checks are important initial quality check procedures. Noise monitoring equipment should be calibrated before and after each usage. Equipment should also be NIST calibrated annually or at manufacturer recommended intervals. There is an economic advantage to purchasing frequently used equipment or renting it for initial or sporadic usage. Floor layout plans and recordkeeping sheets should be organized and partially completed to speed pre-shift set up. Noise dosimeter surveys typically run full shift and plant employees are in a hurry to get set up with the equipment and return to their post. Noise dosimeters should be frequently checked to verify operating condition and maintenance of position. On occasion an employee will remove a unit or the microphone element may come unplugged or sustain damage. It is imperative that the consultant remain on site for the full test duration to oversee equipment and maintain chain of custody.

¹³ Occupational Safety and Health Administration, Appendix III:A. Instruments Used to Conduct a Noise Survey , <http://www.osha.gov/dts/osta/otm/noise/exposure/instrumentation.html>

¹⁴ Cheremisinoff, Nicholas, Noise Control in Industry: A Practical Guide, William Andrew, Inc., 1996, p. 123

If employees are to be fitted with noise dosimeters, a short explanatory meeting with Q & A should be held the day before or morning of the survey. Common employee misconceptions include fears that conversations are being recorded or that placing the dosimeter next to a loud radio for a few moments will skew results. Employees should be given the consultant's name and instructed to call should a need arise to leave work early or if equipment problems arise. Employee lunch travel plans should be determined as equipment should not be worn off premises. Arrangements to remove and refit equipment can be made. OSHA requires that employees be allowed to observe monitoring activities and receive results.

The development of the final noise exposure assessment report should incorporate data tables, individual employee noise measurement records, layout plans with equipment locations, and relevant recommendations in addition to standard format. OSHA requires that employers inform all employees who are exposed to noise levels of 85 dB(A) or greater.

Audiometric Testing

A baseline and annual audiometric test program must be established for employees exposed to noise exceeding the OSHA Action Level. Baseline and annual hearing tests are then compared to look for early signs of hearing loss and appropriate action. These tests must be conducted by medically qualified professionals using calibrated test equipment as specified by the standard. Employees may be sent to an off site audiology clinic or an audiology booth/van can be brought to the work site for testing. The OSHA standard directs that employees take a hearing test after at least 14 hours of nonwork or quiet working conditions or after wearing hearing protection while working in noisy conditions. This practice, frequently not followed, will reduce the likelihood of a temporary threshold shift being identified as hearing loss. Baseline audiograms should be accomplished in a timely manner and may assist in the identification of employees with pre-existing hearing loss.

Audiology professionals will prepare a report of each employee's results and should additionally identify problem audiograms. Experience shows that the quality and completeness of these reports vary widely and they should be reviewed. Also employees missing a test date should be rescheduled. It is important that all employees with a Standard Threshold Shift (STS) in hearing be identified and followed up. Employees must be informed of an STS within 21 days. Employees with STS may be retested by the employer within 30 days. OSHA will not allow the retest to stand in place of the initial exam if completed after 30 days. Typically the employee is also medically evaluated for other ear problems which may obstruct hearing, refitted with hearing protection, and retrained in Hearing Conservation.

Training

The OSHA standard requires that all employees exposed to noise above 85 dB(A) be trained annually as part of a Hearing Conservation Program. Training programs should incorporate the effects of noise on hearing, hearing protection types and fitting, and audiometric testing purpose and procedures. Hearing protection fit and enforcement are often overlooked aspects.

Noise Control

OSHA first requires engineering controls be investigated to reduce employee overexposure to noise. If engineering controls are infeasible or do not work, then at least two different types of hearing protection must be provided. Hearing protection devices are labeled with a Noise Reduction Rating (NRR) which should be evaluated according to OSHA 1910.95 Appendix B. Enforcement of hearing protection usage is required when an employee's 8 hour time weighted average exposure exceeds 90 dB(A) or when an employee with a Standard Threshold Shift is exposed above 85 dB(A). The OSHA Noise Control Manual is a useful resource and provides helpful suggestions.¹⁵

Bibliography

1. Berger et al, American Industrial Hygiene Association (AIHA). The Noise Manual Revised Fifth Edition, AIHA Press 2003
2. Council for Accreditation in Occupational Hearing Conservation, <http://www.caohc.org/ohc/ohccertified.php>
3. Cheremisinoff, Nicholas, Noise Control in Industry: A Practical Guide, William Andrew, Inc., 1996, p. 123
4. Daniell, William et al, "Increased Reporting of Occupational Hearing Loss: Workers' Compensation in Washington State 1984 – 1998, American Journal of Industrial Medicine, Volume 42, Issue 6, 2002, Wiley Interscience, p.502
5. Daniell, William et al, Occupational Hearing Loss in Washington State, CDC/NIOSH 5 R01 OH 03894-03, January 10, 2005, p. viii
6. Erdrich, John, "Analysis of Audiometric Database Shows Evidence of Employee Fraud," Acoustical Society of America Journal, Volume 114, Issue 4, pp. 2373-2374, 2003
7. ¹ Humes, Larry, et al, Noise and Military Service: "Implications for Hearing Loss and Tinnitus," National Academies Text, Washington, DC, 2005.
8. National Institute of Occupational Safety and Health, "Criteria for a Recommended Standard: Occupational Noise Exposure," Publication 98-126, 1998
9. Occupational Safety and Health Administration, Appendix III:A. Instruments Used to Conduct a Noise Survey , <http://www.osha.gov/dts/osta/otm/noise/exposure/instrumentation.html>
10. OSHA, "Noise and Hearing Conservation," <http://www.osha.gov/dts/osta/otm/noise/index.html>

¹⁵ OSHA, "Noise and Hearing Conservation," <http://www.osha.gov/dts/osta/otm/noise/index.html>

11. OSHA.gov – Frequently cited standards for Manufacturing and Construction
12. Rabinowitz, Peter, MD, MPH, “Determining When Hearing Loss is Work Related,” CAOHC Update, Fall 2005
13. Victoria Parliament, “1.7 Industrial Deafness Alert 5,”Scrutiny of Acts and Regulations Committee, Parliament of Victoria
http://www.parliament.vic.gov.au/sarc/Alert_Digests_94/alert5b.htm