Occupational Noise Exposure

Collin Henning, MPH

Noise is any unwanted sound, especially one that is loud or unpleasant or that causes disturbance. Every day noise is encountered that interferes with communication, and can be hazardous to health. The effects of sound on a person depend on three physical characteristics of sound: amplitude, frequency and duration (NIOSH, 1998). Occupational hearing loss is one of the most common work-related illnesses in the United States and approximately 22 million workers are affected (CDC, 2004). Some of the ailments associated with excessive noise include temporary and permanent threshold shifts and noise induced hearing loss. Threshold shift is defined as a change in hearing thresholds of an average 10 dB or more at 2000, 3000 and 4000 Hz in either ear (NIOSH, 1998)

Sound pressure level, expressed in decibels, is a measure of the amplitude of the pressure change that produces sounds (NIOSH, 1998). The decibel can be measured in three scales, the A, C, and Z scale. The A scale is an expression of the relative loudness of sounds in air as perceived by the human. The C scale is unweighted and has no filtering. The Z scale is less often used and is a flat frequency response.

There are three different types of noise: continuous, intermittent and impact. Noise is continuous if the magnitude does not vary over time, intermittent noise stops and starts at intervals and impulsive noise is large in magnitude but short in duration (Holt). All of these types of noise can be dangerous to health in the short and long term. The intensity of noise varies with the decibel exchange rate. Different agencies and even different countries use different decibel exchange rates. An exchange rate is the increase or decrease in decibels corresponding to twice (or half) the noise dose (OSHA Manual). In other words, for a 3 dB exchange rate if a noise is recorded at 60 dB(A) and at 63 dB(A), the noise at 63dB(A) is twice as loud as the noise at 60 dB(A). For a 5 dB exchange rate, if a noise is recorded at 80 dB(A) and 85 dB(A), the noise at 85 dB is twice as loud as the noise recorded at 80 dB(A).

The Occupational Safety and Health Administration (OSHA) have enforceable limits on the amount of noise an employee can be subjected to a normal 8 hour work day using the Time Weighted Average (TWA). The TWA is the averaging of different exposure levels during an exposure period. The National Institute of Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH) use Recommended Exposure Levels (REL) and Threshold Limit Values (TLV), respectively, as guidelines for the amount of noise an employee can be subjected to on a normal 8 hour day using the TWA. The standards and recommendations of these agencies are put into place to conserve hearing.

In the United States, OSHA has the authority to cite companies that are not within regulatory standards. The OSHA regulation states that an employee is allowed to be subjected to, without the use of personal protective equipment, 90 decibels using the A weighted scale, for

an 8 hour TWA, based on a five decibel exchange rate. This standard is based on scientific studies and economic feasibility. Additionally, OSHA has an action level, for which no citation can be written, of 85 decibels for an 8 hour TWA. If an employee's exposure is in excess of the action level, they must be enrolled in a hearing conservation program.

Another way to view this standard is in terms of dose. Noise dose is the measured sound exposure level normalized to an 8-hour working day. Using the 5 dB exchange rate, 90 dB(A) is the equivalent of a 100% dose, and the 85 dB(A) is equivalent to a 50% dose. This means that if an employee works longer than 8 hours a day, and whose TWA is under the enforceable 90 dB(A) limit it is possible that the employee can have a noise overexposure based on dose. The same holds true if an employee works shorter than an 8 hour day and whose TWA is over the 90 dB(A) limit that the employee may not be overexposed based on the dose received.

In other countries, such as Canada, the European Union, the United Kingdom, and Singapore, the standard is more stringent. The regulatory standards are similar to the ACGIH guidelines, which correspond closely with the NIOSH REL. The Permissible Exposure Limits (PEL) are based on an 85 dB(A) TWA for an 8 hour work day, based on a 3 dB exchange rate. An employee must also be enrolled in a hearing conservation program if they exceed the PEL. With a 40-year lifetime exposure at the 85 dB(A) PEL, the excessive risk of developing occupational noise induced hearing loss is 8%, considerably lower than the 25% excess risk at the 90 dB(A) PEL currently enforced by OSHA (NIOSH, 1998).

NIOSH recognizes that noise-induced hearing loss is preventable. This perspective is reflected in the REL of 85 dB(A), for an 8 hour TWA with a 3 dB exchange rate. Additionally, hearing protection is suggested for any noise exposure over the REL. In 1972, NIOSH had proposed the use of a 5 dB exchange, but since then scientific studies have supported to the 3 dB exchange rate as more accurate and this view has gained national and international consensus (NIOSH, 1998). A study that compared the NIOSH noise criteria and the OSHA hearing conservation criteria found that if the NIOSH criteria was applied then the employees enrolled in the hearing conservation program would increase from 23% to 75% of the study population (Sriwattanatamma et. al. 2000).

Noise can be produced from a variety of machines and heavy equipment. It is imperative that these types of operations continue to operate in good working order to reduce the potential for excess noise sources. The hierarchy of controls can be used as guidance for implementing the best control measures. If the potential for excess noise exposure exists, engineering controls to separate the worker from the path of the noise source is necessary. This could include the use of a shield or enclosure to isolate the worker from the noise source. Other control recommendations used to mitigate noise are noise reducing nozzles and sound foam insulation. If engineering controls are not feasible, administrative controls are the next best option. Personal protective equipment is the last line of defense when it comes to protecting workers from noise and is not viewed as a solution because the worker is still in the presence of the noise source.

If an effort to help employers more aware of the potential noise sources from tools, machines and equipment NIOSH has started the Buy Quiet initiative. This initiative encourages manufacturers to prevent noise source exposure by designing equipment that is quieter and for employers to rent or purchase equipment with the lower noise. The information is provided on the label of the equipment and helps employers make more informed decisions. This option has the potential to be cheaper to the employer and the employer does not have to spend money to make alterations to equipment. This initiative also helps employers to more easily comply with OSHA noise standards by reducing the noise the employees are potential exposed to.

Studies have shown that the most important determinant of exposure level is worker occupation (Conch-Barrientos et. al, 2004). SOMA has many years of experience sampling for noise in production and manufacturing facilities, mining operations, steel mills, power plants and commercial settings. Through the use of personal dosimetry which measures a person's cumulative exposure to noise over a period of time with a dosimeter, area surveys measured at different sites across an area and engineering surveys measured using a variety of instruments; it is possible to identify potential hazardous tasks, machines or areas. The potentially high exposure tasks or areas can be represented by a sound map. Sound mapping is one helpful tool that employers can use to highlight potentially dangerous areas. This is possible through gaining an understanding of the work processes and establishing a baseline for worker exposure. Once a hazardous area has been identified corrective actions can be proposed and controls implemented. Follow-up sampling is highly recommended to definitively determine if the implemented control is having the desired effect.

References

Centers for Disease Control and Prevention. Noise and Hearing Loss Prevention.

Concha-Barrientos M, Campbell-Lendrum D, Steenland K. Occupational noise : assessing the burden of disease from work-related hearing impairment at national and local levels. Geneva, World Health Organization, 2004. (WHO Environmental Burden of Disease Series, No. 9).

Holt, Rinehart and Winston. Laboratory Manager's Professional Reference.

NIOSH (1998). Criteria for a recommended standard: occupational noise exposure. Revised criteria 1998. Cincinnati, OH, National Institute for Occupational Safety and Health (http://www.cdc.gov/niosh/98-126.html).

Occupational Safety and Health Administration. Noise and Hearing Conservation Technical Manual.

Sriwattanatamma, Patra, and Patrick Breysse. "Comparison of NIOSH Noise Criteria and OSHA Hearing Conservation Criteria." *American Journal of Industrial Medicine* 37.4 (2000): 334-38.