

## Risk Control

### Noise and Noise Induced Hearing Loss

#### Introduction

We have known for at least 100 years that excessive exposure to noise can result in permanent hearing loss. However, even with this knowledge and solutions to the problem available, workers continue to incur noise induced hearing loss. The following information will give the reader a general description of ways to effectively recognize, evaluate, and control excessive noise in the workplace.

Noise induced hearing loss is preventable; however it may occur after many years of exposure to high levels of noise. Engineering controls are the preferred method for protecting worker hearing. If engineering controls are not feasible, or if they cannot reduce noise exposure to an acceptable level, mandatory use of hearing protection devices (HPD) is required. OSHA standard 29 CFR 1910.95 requires noise exposure be controlled below a 90 decibel time weighted average and that employees exposed to 85 decibel or more be placed in a hearing conservation program.

#### Magnitude/Financial Implications

NIOSH estimates that 14% of the working population is employed in environments where noise levels exceed the OSHA permissible exposure limit (PEL) of 90 dB(A). Some of these occupations include agriculture, mining, construction, manufacturing and utilities, transportation, and military.

Industry specific studies reveal that 44% of carpenters and 48% of plumbers reported that they had a hearing loss. Of coal miners, 90% will have a hearing impairment by age 52 (compared to 9% of the general population.)

NIOSH has stated that 1.7 million workers between the ages of 50 and 59 with various occupations in the U.S. have compensable noise-induced hearing losses and that 10% of all employees exposed to noise levels of 90 dB(A) or above will experience a disabling hearing loss. This is an estimate as there is no national surveillance or injury reporting system for hearing loss. As such, comprehensive data on the economic impact of hearing loss is not available. Some estimates, however, find that compensation costs alone for occupational hearing loss may reach into the hundreds of millions of dollars per year. The following examples indicate the economic impact of occupational hearing loss:

- In the state of Washington in 1991, disability settlements for hearing related conditions cost \$4.8 million. This figure excludes medical and personal costs, which could increase this number substantially. The cost of a hearing aid is approximately \$1500 and a year's worth of batteries, \$300.
- In British Columbia between 1994 and 1998, \$18 million was paid out in permanent disability to 3,207 workers suffering hearing loss. An additional \$36 million was paid out for hearing aids.
- By implementing a hearing conservation program, the U.S. Army saved \$504.3 million by reducing hearing loss among combat arms personnel between 1974 and 1994.
- Between 1987 and 1997, as a result of military efforts to reduce hearing loss among civilians, the Department of Veterans Affairs saved \$220.8 million and the Army an additional \$149 million.

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## Hazards/Exposure

Job related risk factors involved with noise induced hearing loss are:

- Type of noise worker is exposed to (continuous or impulse),
- Average sound pressure level (loudness) in dB(A),
- Duration of exposure both on a daily basis and over a working lifetime.

Continued high noise exposure throughout employment can result in permanent hearing loss by damaging tiny hair-like cells in the inner ear, responsible for sending the incoming messages to the brain. In addition, excessive exposure to noise may cause non-auditory effects including:

- **Psychological**- Sudden noise can startle, annoy and disrupt concentration.
- **Communication**- Excessive noise can reduce comprehension of the spoken word and result in other safety and performance issues such as missing warning signs and signals.
- **Physiological**- Noise can contribute to job stress, constriction of blood vessels, fatigue, and increased blood pressure and heart rate.

## Recognition/Evaluation

Sound is a pressure variation most commonly occurring in air that can be detected by the human ear. It is generated from a vibratory disturbance and made up of tones, which are expressed as the number of vibrations per second in units of Hertz (Hz). Audible sound lies between 20 Hz and 20,000 Hz. The intensity of pressure (or loudness) is measured in decibels (dB). When the sound is unwanted, excessively loud or unpleasant, we refer to it as noise. Occupational noise sources include:

- Machinery,
- Fluid flow (compressed air, steam, liquids), and
- Impact of materials

Areas in the workplace that seem “noisy” (verbal communication is hampered) should be evaluated:

- Noise levels in any given area can be documented using a sound level meter and audio dosimeters. Employees exposed to average noise levels above 90 dB(A) must be included in a mandatory hearing protection program.
- Using sound level meter and audio dosimeter results, areas requiring a hearing conservation program can be documented. Employees exposed to noise levels of 85 dB(A) or above must be included in a hearing conservation program.
- A review of the OSHA 300 log can indicate the need for hearing protection as well. If an employee experiences a Standard Threshold Shift (a 10 dB shift in hearing acuity averaged across 2,000, 3,000, and 4,000 Hz) that has also resulted in a 25 dB level of hearing above audiometric zero at the same frequencies, it must be recorded on the OSHA 300 log.

Audiometric records should be reviewed after each audiogram to determine if employees have suffered and OSHA Standard Threshold Shift (STS).

## Hazard/Exposure Control

The following control measures should be taken to protect workers from noise induced hearing loss:

1. Noise exposure evaluations should be completed.
  - a. Monitors should meet OSHA specifications (Type 2; Slow Response; A-Scale).
  - b. Evaluation should be reassessed whenever employees’ noise exposure changes.
  - c. Evaluation results must be documented.
2. Employee noise exposure must be categorized.
  - a. There must be a list of all areas or employees whose exposure exceeds 90 dB(A).
  - b. There must be a list of all areas or employees whose exposure exceeds 85 dB(A).
  - c. There must be a list of all areas or employees whose exposure is less than 85 dB(A).

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3. Warning signs should be posted in areas where noise exceeds 90 dB(A).
4. Corrective action should be taken in areas where employee noise exposure exceeds 90 dB(A).
  - a. Feasibility studies for engineering controls should be made and documented.
  - b. All feasible engineering controls must be implemented.
  - c. Documentation to show nonfeasibility of engineering controls must be available.
  - d. Areas where noise cannot be reduced below 90 dB(A) must be mandatory hearing protection areas.
5. An OSHA Hearing Conservation Program should be in place.
  - a. All employees exposed above 85 dB(A) must be in a Hearing Conservation Program.
  - b. Annual Audiograms should be provided.
  - c. Baseline and annual audiograms must be evaluated by a health care professional.
  - d. At least two different types of hearing protectors should be available.
  - e. Employees must receive annual training in Hearing Conservation.
  - f. A copy of the Hearing Conservation Amendment should be posted.

## Engineering Controls

Take action to reduce noise exposure or require hearing protection in all areas where average employee exposure exceeds 90 dB(A). Per OSHA 29 CFR 1910.95 (b)(1) "When employees are subjected to sound exceeding 90 dB(A) TWA, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels below 90 dB(A), personal protective equipment shall be used to reduce sound levels..."

Engineering controls include but are not limited to:

- Changes in machinery and equipment.
  - preventing or reducing impact between machine parts
  - reducing speeds gently between forward and reverse movements
  - enclosing especially noisy machine parts
  - isolating vibration related noise sources within machines
  - providing mufflers for the air outlets of pneumatic valves
  - changing to more quiet fans and placing mufflers in the ducts of ventilation systems
- Materials handling.
  - reducing the dropping height of materials being collected in bins/boxes
  - increasing the rigidity of containers receiving impact from materials being collected in bins/boxes
  - use soft rubber or plastic to receive hard impact
  - belt conveyors are generally quieter than rollers
- Enclosure of machines
  - using a dense material, such as sheet metal or plaster board, on the outside
  - using a sound absorbent material on the inside
  - installing easily opened doors as required for machine adjustment and service
- Control of noise for vibrating surfaces
  - isolating the floor from machine vibrations
  - providing vibration isolation of machine surfaces to reduce sound emission
- Damping with absorbents
  - coating the ceiling and walls with effective sound-absorbing material
- Maintenance of equipment
  - ensuring proper lubrication
  - replacing defective equipment
  - repairing loose parts.

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## Administrative Controls

When engineering controls are not feasible or cannot reduce noise levels to below 90 dB(A), a combination of engineering and administrative controls may be effective.

Examples of administrative controls include:

- Reducing the duration of exposure, i.e. noisy equipment that is used less than full time could be arranged to run a portion of one day, rather than all day one day a week.
- Reducing the number of employees exposed, i.e. perform high noise level operations on shifts when a minimum number of employees will be exposed.

## Hearing Protection Devices (HPDs)

If studies indicate engineering controls are not feasible, hearing protection devices should be used to help demonstrate compliance with the regulations. Use of HPDs should be required for all employees with an 8-hour TWA exposure of 90 dB(A) or greater.

At least two types of HPD should be offered, both of which will provide sufficient attenuation of the worker's noise exposure. The U.S. EPA Noise Reduction Rating (NRR) using the OSHA modifier formula should be used to determine if the attenuation is sufficient. Appendix B of 29 CFR 1910.95 explains how to estimate adequacy of hearing protector attenuation. Employees should be included in the final selection of HPD to assist in acceptance.

Since NRR was obtained under ideal conditions, a more realistic NRR should be calculated as follows:

$(\text{NRR} - 7\text{dB}) = \text{adjusted NRR}$

Employee 8-hour TWA minus the adjusted NRR should equal 89 dB(A) or less. However, a more conservative goal should be 85 dB(A) or less.

Examples of Hearing Protection Devices include:

### Ear Muffs

#### *Advantages*

- Nothing is inserted into the ear
- Three different band positions: over the head, behind the head, under the chin
- One size fits most people
- Large size makes earmuffs difficult to lose or misplace
- Size allows supervisor to quickly check compliance
- Good in environments requiring frequent removal

#### *Disadvantages*

- More expensive
- Requires regular maintenance and cleaning
- Can be uncomfortable in hot environments
- Can be heavy on the head
- Concurrent use of eyeglasses can disrupt acoustic seal

### Ear Caps (Semi-Insert)

#### *Advantages*

- Soft pads seal out noise at outer ear canal without entering the canal
- Hard to lose, band keeps both pads together
- Allows easier compliance checks
- Cooler than muffs
- Not affected by safety glasses

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## *Disadvantages*

- Lower NRR than other HPD
- May be uncomfortable to some people due to band pressure
- May interfere with hard-hats or respirators

## Ear Plugs

### *Advantages*

- Soft material fits into ear canal to seal out noise
- Small, easy to carry
- Most comfortable for long-term wear
- Will not interfere with glasses, hard hats or other PPE
- Typically has the highest NRR
- Lowest cost per unit
- Less maintenance, especially for disposable protectors

### *Disadvantages*

- Requires the most effort to fit and wear properly.
- Worker may object to inserting object into ears.
- Inconvenient if frequent removal occurs.
- Easier to lose, typically needs frequent replacement.

## **Hearing Conservation Program**

Implement a hearing conservation program where employees are exposed to a time-weighted average of 85 dB(A) or greater. A proper Hearing Conservation Program consists of:

- Annual audiometric testing of employees where employees are exposed to a time-weighted average of 85 dB(A)
- Periodic monitoring of employee noise exposure
- Availability of hearing protection for voluntary employee use (mandatory use under certain conditions)
- Annual employee training on effects of noise on hearing, how to use hearing protectors, and the audiometric testing program
- Maintain accurate records in regards to employee exposure and individual audiograms

Ensure a qualified physician or audiologist reviews the annual audiograms and there is follow-up on each identified standard threshold shift (STS). Develop a follow-up procedure for employees identified as having a standard threshold shift including:

- Written notification to the employee
- Fitting and requiring employee to use hearing protectors
- Follow-up with a health care professional

## **Training**

Employees in the Hearing Conservation Program should attend an initial training session when they first enter the program and annually thereafter. The content of the training program should include:

- Effects of noise on hearing
- Purposes, advantages, disadvantages, attenuation, and fitting, care, use of HPD
- Purpose of audiograms and explanation of test procedure

## **Recordkeeping**

Maintain all required documents including:

- Audiometric test records
- Employee noise exposure records
- Background sound pressure levels in the audiometric test location

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## References

Michigan Department of Consumer and Industry Services. "Noise and the Noise Standard."

NIOSH. "Work-Related Hearing Loss." <http://www.cdc.gov/niosh/01-103.html>

NIOSH. "A Practical Guide to Preventing Hearing Loss." <http://www.cdc.gov/niosh/96-110.html>

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