

Noise and hearing conservation

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This publication provides practical workplace safety and health information to assist you in making your place of work safer. It is not legal advice. SAIF has made every effort to bring significant Oregon Occupational Safety and Health Administration (OR-OSHA) regulations to your attention. Nonetheless, compliance with OR-OSHA remains your responsibility. You should read and understand all relevant OR-OSHA regulations that apply to your job site(s). You may want to consult with your own attorney regarding aspects of OR-OSHA that may affect you.

Note: The information in this publication is time sensitive. Do not rely upon this document if its publication date is more than three years old. Please check the "Safety and health" section of our web site at saif.com/safetyandhealth for a more recent, printable copy. You'll also find a variety of other valuable safety information designed to help your business prevent injuries and control costs.

Introduction

Employers with workplaces that have excessive levels of noise need to implement a comprehensive noise control program to reduce their workers' risk of noise-induced hearing loss and to prevent workers' compensation claims.

This resource is to help you build a noise and hearing conservation program for continuous or steady-state noise, the most common cause of noise-induced hearing loss in workers. If your workplace has exposure to "impact" noise (when noise impulses occur at peak level in intervals), please contact SAIF's industrial hygiene program, toll-free at 800.285.8525 for additional information.

Controlling exposures is a critical part of building a workplace well-being culture, part of a Total Worker Health® (TWH) approach. Protection from workplace hazards and exposures is an important injury and illness prevention practice. Workers that are physically and mentally healthy have fewer injuries, return to work sooner when they are injured, are more productive, and experience higher levels of satisfaction. Employers benefit from lower insurance costs, better employee retention, and less absenteeism. Consider learning more about TWH at saif.com/twh.

Noise and hearing conservation overview

Whether noise produces a permanent loss of hearing in exposed workers depends on several factors:

- Volume frequency, or pitch (how low or high the noise is)
- Exposure time
- Individual susceptibility to noise-induced hearing loss
- Presence of engineering controls

The more intense or louder the noise, the more likely it will contribute to hearing loss. The longer a worker is exposed to a particular noise, the greater the risk of injury to the auditory system.

The Oregon Occupational Safety and Health Division (Oregon OSHA) requires workplace noise exposures be below the 8-hour time-weighted average (TWA) permissible exposure limit (PEL) of 90 decibels measured on the A scale (dBA) with a slow response time. A hearing conservation program is required for employees exposed to an 8-hour TWA at or above 85 dBA.

Table 1 shows the National Institute for Occupational Safety and Health (NIOSH) risk estimates for material hearing impairment after a working lifetime exposure to occupational noise [ref. NIOSH Occupational Noise Exposure, Ch. 3 Basis for the Exposure Standard, Table 3-1.]. In other words, for a group of 100 workers consistently exposed to noise sources at 85 dBA, we would expect to see 15 individuals (or 1 in 6) with significant hearing loss. About 1 of every 3 workers would be expected to lose a significant portion of their hearing at 90 dBA.

It is also important to note the impact of hearing impairment on occupational safety. A study published in the Journal of the American Medical Association showed that hearing loss is associated with increased risk of occupational injury. Thus, hearing health is a critical element of a safe workplace.

The American Conference of Governmental Industrial Hygienists

(ACGIH®) has adopted a Threshold Limit Value (TLV®) of 85 dBA, which is a more conservative approach to hearing conservation. It also corresponds with the NIOSH REL (Recommended Exposure Limit). The parameters for the TLV® include a threshold of 80 dB, a criterion level of 85

TABLE 1: Estimate of excess risk of material hearing impairment at age 60 after a 40-year working lifetime exposure to occupational noise	
<i>Average Exposure Level</i>	<i>Risk of Hearing Impairment</i>
90 dBA	29 %
85 dBA	15 %
80 dBA	3 %

dB, A-weighting, slow response, and a 3 dB exchange rate. The premise behind the 3 dB exchange rate promoted by ACGIH® and NIOSH is that equal amounts of sound energy will produce equal amounts of hearing impairment, regardless of how the sound energy is distributed over time.

Accordingly, ACGIH® and SAIF recommend that a hearing conservation program, including required hearing protection and engineering controls, be implemented when exposures approach or exceed the 85 dBA TLV®. Following the most protective standard is considered a best practice among industrial hygienists.

Studies on manufacturing and production workers have shown an increased risk of cardiovascular disease and elevated blood pressure for workers chronically exposed to noise at or above 85 dBA.

Ototoxic substances

Exposure to certain chemicals may also result in hearing loss and may exacerbate the effects of noise on hearing. In settings where there may be exposure to noise and carbon monoxide, hydrogen cyanide, lead, and solvent mixtures, or exposures to ethylbenzene, styrene, toluene, or xylene in the absence of noise, periodic audiograms are advised and should be carefully reviewed, with the potential confounding effect of noise in mind. Other substances under investigation for ototoxic effects include arsenic, carbon disulfide, chlorobenzene, mercury, nitriles, n-hexane, pesticides, and trichloroethylene.

If workplace exposures reach or exceed an 8-hour TWA of 90 dBA, an employer must use one of the following methods to limit employee exposure to noise:

1. Engineering controls

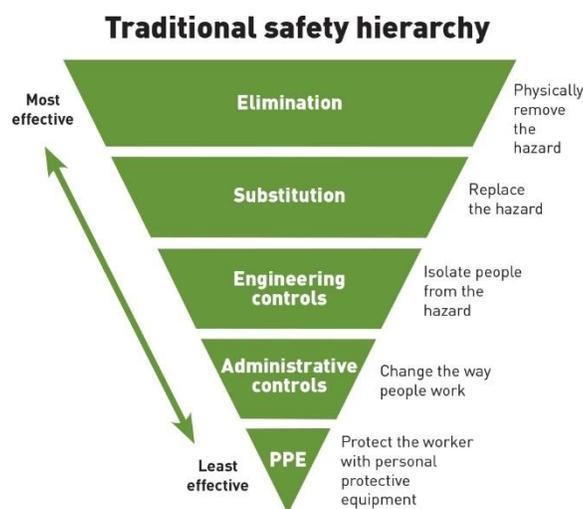
Reduce noise by eliminating or enclosing the noise source, placing employees in sound-proof booths, installing sound-dampening materials, or purchasing less noisy machinery.

2. Administrative controls

Rotate employees from noisy areas to quieter areas so that the exposure time to high intensity noise, and the TWA exposure level, is reduced.

3. Personal protective equipment

Require the use of appropriately selected hearing protection to reduce the amount of noise entering the employee's ear.



Remember to follow the hierarchy of controls to the extent possible. Engineering controls are the most desirable method of controlling noise, followed by administrative controls, and the use of personal protection equipment (PPE) only as a last resort. This is because PPE, such as ear plugs, may be worn incorrectly or inconsistently or not worn at all by employees, thus reducing protection.

Oregon OSHA administrative rules summary

I. Noise exposure

The permissible noise exposure section requires engineering or administrative controls to reduce exposures exceeding 90 dBA for 8 hours; 92 dBA for 6 hours; 95 dBA for 4 hours; 97 dBA for 3 hours; 100 dBA for 2 hours; 102 dBA for 1.5 hours; 105 dBA for 1 hour; 110 dBA for 30 minutes; and 115 dBA for 25 minutes or less. The impulse or impact noise standard allows no sound level exceeding 140 dBA peak sound pressure level. Only noise levels at or above 90 dBA must be considered for controls.

II. Hearing conservation

An employer is required to institute a Hearing Conservation Program whenever employee noise exposures equal or exceed an 8-hour TWA of 85 dBA, or a noise dose of 50%. This is known as the "action level."

The employer must monitor employee's exposures to determine whether they exceed the 8-hour TWA of 85 dBA. The requirement for noise dosimetry includes all "continuous, intermittent, and impulsive sound levels from 80 dBA to 130 dBA." The audiometric testing program requires that audiometric testing be provided to all employees whose exposure exceeds the 85 dBA TWA "action level." The baseline audiogram must be provided within six months of placement in a job with noise exposures above 85 dBA. This audiogram should be preceded by at least 14 hours of quiet. The annual audiogram may be obtained at any time during the work shift.

If the annual audiogram reveals a change in hearing threshold relative to the baseline audiogram of an average of 10 dBA or more at 2,000, 3,000 and 4,000 Hz in either ear, the employee must be notified in writing within 21 days and additional follow-up is required. This change is called a "standard threshold shift."

The area in which audiometric exams are conducted must be tested to show that background noise levels are low enough. The audiometer must be checked each day on a person whose hearing is stable. This is the daily biological calibration. In addition, the audiometer must be acoustically calibrated at least annually.

Hearing protectors must be made available to all employees exposed above the 85 dBA TWA. The employer must enforce their use by employees who are exposed above 90 dBA (at 85 dBA or above for employees who experience a standard threshold shift). For those employees who do have a standard threshold shift, the hearing protector must also attenuate the noise level so that the calculated exposure at the inner ear is 85 dBA or below. For all other employees, the attenuation must only reduce the exposure to 90 dBA as an 8-hour TWA.

The attenuation factor or Noise Reduction Rating (NRR) is found on each package of hearing protectors. To calculate the dBA attenuation, subtract 7 from the NRR, and then subtract the remaining NRR from the noise level. Thus, if the noise level is 100 dBA, a NRR of 25 would reduce the exposure to 82 dBA.

The employer must provide a training program and repeat it annually.

The employer must keep records of exposure measurements, audiograms, audiometer calibration, and audiometric test area background noise.

Instructions for various worker exposures

8-hour average exposure below 85 dBA

(daily noise dose less than 50%)

1. No requirements.
2. Recommend maintaining any records from noise dosimetry or sound level surveys, or results from audiometric tests.

8-hour average exposure of 85 to 90 dBA

(daily noise dose 50 to 100%)

1. Complete noise evaluation. Records must be kept for two years, but SAIF recommends maintaining these records indefinitely.
2. Audiometric examinations
 - a. Oregon OSHA requires records to be kept for length of employment. SAIF recommends maintaining these records indefinitely.
 - b. Baseline test within six months of hire. SAIF recommends testing at hire date.
3. Audiograms indicating hearing loss must be reviewed by a qualified specialist.
4. Referral of employees with hearing loss to a qualified specialist at no cost to the employee.
5. Hearing protection devices made available at no cost for all employees exposed to over 85 dBA 8-hour average sound level.
6. Hearing protection use is mandatory for employees with a hearing loss. Hearing protectors must have a Noise Reduction Rating (NRR) sufficient to reduce the 8-hour average noise exposure to 85 dBA or below. If no hearing loss is observed, hearing protection use is optional. However, SAIF recommends the use of hearing protectors for exposures above 85 dBA.
7. Employer must provide a choice of two or more types of hearing protectors.
8. Employees must be trained in the proper use of hearing protectors, purpose of audiometric testing, and effect of noise on hearing.
9. Noise standard and training materials must be made available to employees. A copy of the noise standard must be posted in the workplace.

Average 8-hour exposure above 90 dBA

(daily noise dose greater than 100%)

All of the above requirements, plus the following:

1. Engineering or administrative controls to reduce noise to 90 dBA or below, if technically and economically "feasible."
2. Hearing protection is mandatory for all employees exposed to an 8-hour average sound level of 90 dBA or greater.
3. Hearing protectors must have a NRR sufficient to reduce the average noise exposure to 90 dBA or below.

Training program

Our sense of hearing is often taken for granted. It is only when we lose our hearing that we realize its importance to the quality of our lives. Unfortunately, permanent damage can be done to our sense of hearing before we are aware of it.

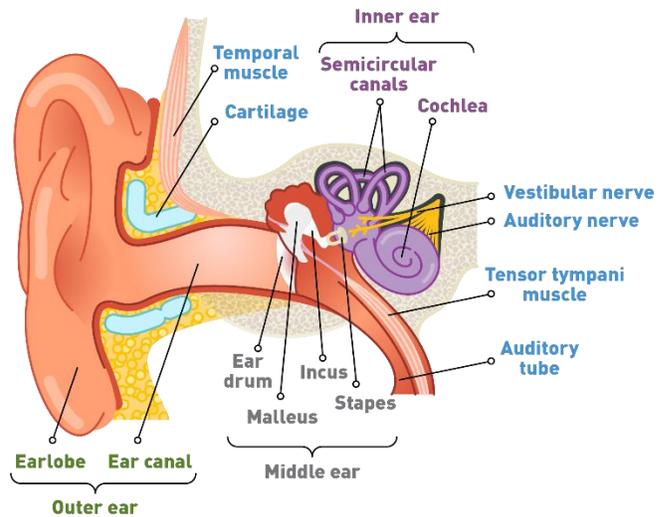
How we hear

Sound waves move through the outer ear and set up vibrations in the middle ear. The vibrations are then transferred to the inner ear. The wave motion in the inner ear is sensed by cells that transmit neural messages to the brain.

Effects of noise on hearing

Prolonged exposure to excessive noise levels can cause a noise-induced hearing loss. When you are exposed to excessive noise levels, the first effect usually is a temporary hearing loss. You may have difficulty hearing a conversation, or the ears may feel “plugged” and “ring.” Over time, an individual who experiences repeated temporary hearing loss will have gradual, permanent, irreversible hearing loss.

Noise-induced hearing loss involves damage to the receptor cells in the inner ear and is classified as sensorineural impairment. Loss of hearing typically begins with a drop in hearing level at the higher frequencies of sound. As the hearing loss continues, it includes the lower sound frequencies that include speech. Early noise-induced hearing loss normally is not detected by an individual, since it occurs above the speech range. By the time an individual is aware of a hearing loss, the amount of loss may be significant.



Audiometric testing

Audiometric testing is a means of determining your hearing ability. “Normal” hearing includes the median hearing level of a large group of American adults between 18 and 25 years of age, with no known history of ear disease and no appreciable high-level noise exposure. The accepted normal range of hearing is between 0 and 25 decibels.

The audiometric test consists of exposing each ear separately to sound at six different frequencies. The audiometric test will indicate an individual’s level of hearing loss, if any. The higher the decibel reading, the greater the hearing loss. As an individual ages, a natural hearing loss called presbycusis takes place. A cold, an ear infection, or recent high-level noise exposure can cause a temporary hearing loss that would produce poor test results.

You can help prevent noise-induced hearing loss by wearing personal protective equipment. There are three types of ear protectors: a muff that covers the entire ear, a plug that is inserted into the ear canal, and a “stopper,” or caps that cover the outer end of the ear canal.

All three types of hearing protectors are designed to reduce the amount of noise reaching the inner ear.

Selection of ear protectors

The manufacturer of each hearing protector will indicate the level of noise reduction, or attenuation, for each type of protector. It will be listed on the package as the Noise Reduction Rating (NRR).

Ear protector selections should be based on employee convenience, comfort, and degree of attenuation. Under attenuating would lead to excessive noise exposure. Over attenuating in moderate noise levels can lead to a feeling of isolation and, consequently, poor acceptance of the protectors.

Fitting

Earplugs must fit tightly to provide a good seal. The earplug is inserted by grasping the ear with the opposite hand, pulling it up and out to open the ear canal, and then inserting the plug with the other hand. Muffs will normally fit all people without difficulty. Eyeglasses may interfere with the proper fitting of the muff. Muffs that attach directly to hard hats are also available. Ear stoppers are typically easy to position. The headband can be worn on top of or behind the head, or under the chin. When hearing protectors are initially worn, it may take some time for the employee to adjust to the new level of sounds. The same sounds are heard, but at a lower intensity.

Care and use of ear protectors

Ear protectors must be maintained in sanitary condition. It is important that employee hands and earplugs are clean when inserted into the ears. If plugs are dirty when inserted, they may cause irritation, which could lead to infection of the ear canal. The same applies to stoppers. Earplugs, when not in use, should be stored in some type of container that can be closed to seal out dust or dirt. Earplugs should be replaced when they no longer can be cleaned or when they lose their pliability. Earmuffs have a replaceable seal that should be kept clean. The seal should be replaced whenever it becomes stiff or cracked.

Table 1: Types of hearing protection devices

Type	Advantages	Disadvantages
<p data-bbox="267 1144 337 1171">Muffs</p> 	<ul data-bbox="479 1150 917 1360" style="list-style-type: none"> • Easy to fit in place and take on and off • Easy for management to monitor their use • Do not irritate the ear canal 	<ul data-bbox="958 1150 1461 1333" style="list-style-type: none"> • Cause pressure on the head • May not have a good seal with glasses or long hair • Are hot to wear in the summer
<p data-bbox="259 1438 345 1465">Inserts</p> 	<ul data-bbox="479 1453 917 1663" style="list-style-type: none"> • Inexpensive • More readily accepted by workers • Can be worn easily alongside other protective equipment (eyewear, hard hat, etc.) 	<ul data-bbox="958 1453 1445 1635" style="list-style-type: none"> • Difficultly in fitting (must fit tightly to be effective) • Tend to loosen with jaw movement • Can irritate ear canal

Recordkeeping

If you are required to keep the OSHA 300 Log, note there has been a change in the criteria for reporting occupational hearing loss. The work-related hearing loss must now be recorded in the log when: (1) An annual audiogram reveals a standard threshold shift in either or both ears; and (2) the hearing level in the same ear is 25 dB above audiometric zero.

A standard threshold shift is defined as an average of 10 dB loss or more in 2,000, 3,000, and 4,000 Hertz in either ear. Prior to January 1, 2003, the requirement called for a log entry when the work-related shift was an average of 25 dB or more. Ensure that your audiometric service provider is notifying you which cases are recordable based on the revised recordkeeping criteria.

The reporting requirements have allowances for age of the employee, retesting within 30 days of the first test, and input by a licensed healthcare professional. These allowances, along with the full requirements, are found in OAR 437-001-0700 (11), Recordkeeping and Reporting.

Resources

Oregon OSHA topic page: Noise

<http://osha.oregon.gov/Pages/topics/noise.aspx>

Federal OSHA safety and health topics: Occupational noise exposure

<https://www.osha.gov/SLTC/noisehearingconservation/index.html>

CDC/NIOSH workplace safety & health topics: Noise and hearing loss prevention

<https://www.cdc.gov/niosh/noise/about/noise.html>

Appendix A: Frequently asked questions

Why does SAIF recommend wearing hearing protection for all employees exposed to between 85 and 90 dBA when Oregon OSHA requires it only for those with threshold shifts?

The Oregon OSHA codes for hearing protection are regulatory requirements. Employees may still experience hearing loss with long-term exposure between 85 and 90 dBA.

The code requires baseline audiograms within six months of an employee's first exposure to noise above 85 dBA. Some employers, however, require audiograms as part of the hiring process. Why?

One reason is to document if hearing loss has occurred prior to employment with your firm. Oregon employers must be able to show that the "last injurious exposure" did not occur with them, or they may be responsible for hearing loss claims. If they wait six months to conduct an audiogram then it may be difficult to know if the employee's hearing loss arose, or if an existing loss worsened, with the current employer rather than prior to being hired.

We provide annual audiograms after the baseline audiogram at time of hire. Should we be monitoring noise levels on an annual basis too?

Re-monitoring should be conducted when there are significant changes in production, process, equipment, or controls that increase or decrease noise levels. This may often be more than 12 months. Monitoring data can be used on a representative basis to determine which employees are to be included in your hearing conservation program.

Our company must implement a hearing conservation program. Does this mean we have to wear hearing protection from now on?

Not necessarily. Hearing protection should be the last resort of control measures. You should first look for ways to reduce noise through engineering or administrative controls.

We have access to a sound level meter. Can we rely on this instrument to determine if a hearing conservation program is required?

Following procedures in Appendix A of OSHA 29 CFR 1910.95, you could rely on a sound level meter to determine if a program is required.

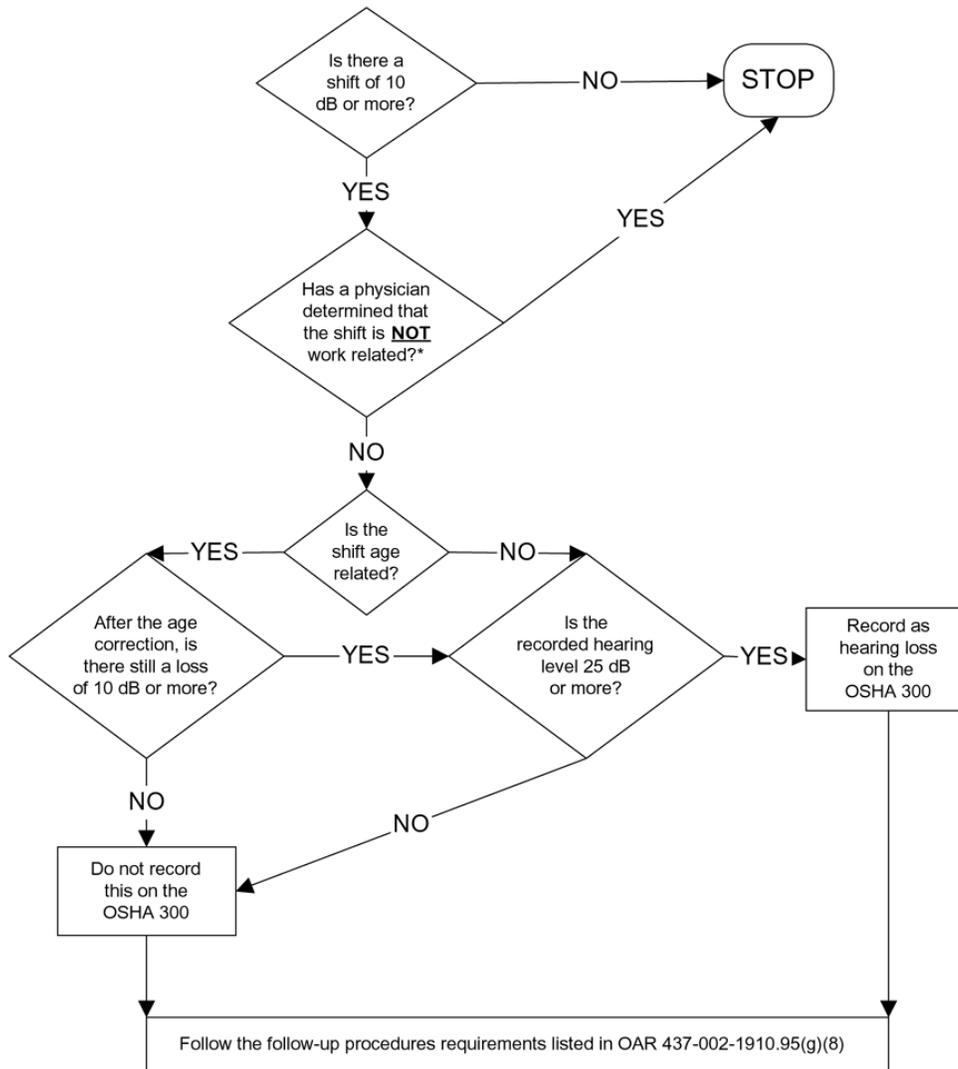
However, area monitoring becomes inappropriate where there is high worker mobility, significant variations in sound level, or a significant component of impulse noise. In these cases, representative personal sampling (noise dosimetry) should be used.

I provide hearing protection for those required to wear it, but it is seldom worn. What is the employer's responsibility?

Providing protection is not enough. Employers are required to ensure that hearing protection is worn when required. If wearing protection is a problem, management should find out why. Several areas to explore are the selection, fitting, and proper use of equipment. The employer should manage the wearing of hearing protection like every other aspect of their business.

Appendix B (non-mandatory) to OR-OSHA OAR 437-001-0700, hearing loss recordability flowchart

All numbers referenced below are taken as an average of the 2,000, 3,000, and 4,000 Hz levels of the audiogram



* 1910.95 assumes that any shift is workplace-induced unless a physician determines otherwise.

Stat. Auth.: ORS 654.025(2) and 656.726(4).
Stats. Implemented: ORS 654.001 through 654.295.
Hist: OR-OSHA Admin. Order 7-2002, f. 11/15/02, ef. 11/15/02.