Project WorkSAFE's

quick guide to hearing protection

Vermont Department of Labor

Contents

About this guide

Project WorkSAFE's quick guide to hearing protection is reprinted, with permission, from an Oregon OSHA Standards and Technical Resources publication. This quick guide is designed for employers and employees who want to know about the noise standard.

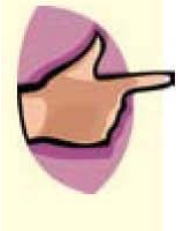
Piracy notice

OR-OSHA: Please contact Ellis Brasch (503)947-7399 or ellis.k.brasch@state.or.us

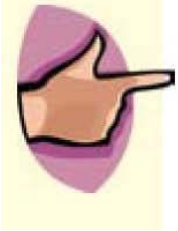
Your hearing: use it, don't lose it.

Most of us take hearing for granted. When we go home after work and when we get up in the morning, we expect to hear. Human hearing is amazingly sensitive. Our ears can distinguish 400,000 different sounds and can detect sounds so quiet they cause the eardrum to vibrate less than 1/80 millionth of an inch. But that remarkable sensitivity doesn't have a lifetime guarantee.

To maintain your hearing, you have to care for it. Noise is as much a part of our lives as the air we breathe. We're exposed to noise at work, at home, and at play. Yet our ability to hear well offers few clues when we put it at risk.



Noise-induced hearing loss is the term for hearing damaged by exposure to excessive noise. The damage to hearing caused by too much noise may not be apparent for years

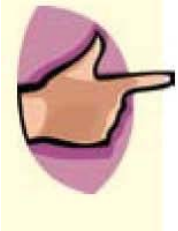


Hearing loss can't be cured. But it can be prevented.

Sound and noise

Sound is what you hear. Yes, a dog can hear sounds that you can't hear and you can feel the sound of a jet as it prepares to take off, but most of us relate sound with things we hear.

One person's noise may be another person's music, but there's a point at which sound becomes a problem for all of us – when it destroys our ability to hear the sounds we want to hear.

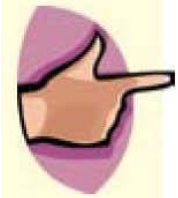


Sound is our sensation of very small, rapid changes in air pressure.
Noise is any sound that you don't want to hear.

How is sound measured?

Sound is measured in two ways: **decibels** and **frequency**. Decibels measure the pressure of sound. Frequency is related to a sound's pitch and is measured in units called hertz (Hz), or cycles per second. The pitch of a sound – how high or low it seems – is how you perceive its frequency; the higher the pitch, the higher the frequency. High-frequency sounds are generally more annoying than low-frequency sounds and can be more harmful to hearing.

Human hearing is most sensitive to frequencies between 3,000 and 4,000 Hz. That's why people with damaged hearing have difficulty understanding higher-pitched voices and other sounds in the 3,000 to 4,000 Hz range.



Children usually have the best hearing and can often distinguish frequencies ranging from the lowest note on a pipe organ (about 20 Hz), to the trill of a dog whistle (20,000Hz).

Sound-measuring instruments

The instruments typically used to measure sound are the **sound-level meter** and the **dosimeter**.

A sound-level meter measures the pressure of sound in a specific area at the moment in time – good for estimating noise exposure in areas where noise levels are relatively constant and workers are not mobile.

A dosimeter measures the noise exposure for one worker over a longer "cumulative" time, such as an eight-hour day.

Sound-level meter

Measures noise at a moment in time.

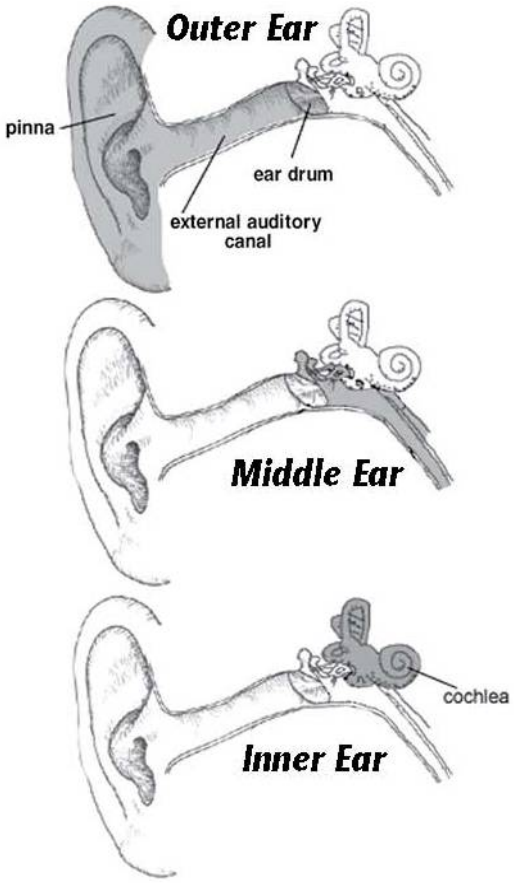
Dosimeter

Measures noise exposure over time.

How does hearing work?

The ear has three main parts; **the outer ear**, **middle ear**, and **inner ear**. The outer ear (pinna) collects sound waves and directs them into the external auditory canal. The eardrum separates the auditory canal from the middle ear. Small bones in the middle ear transfer sound to the inner ear. The inner ear contains the cochlea, the main sensory organ for hearing, and nerve endings leading to the brain.

All sounds produce waves. Sound waves funnel through the opening in your outer ear, travel down the auditory canal, and strike the eardrum, causing it to vibrate. The vibrations pass the small bones of the middle ear, which transmit them to sensory cells – called **hair cells** – located in the cochlea. The vibrations become nerve impulses and go directly to the brain, which interprets the impulses as sound.



How loud is too loud?

Because people differ in their sensitivity to sound, there's no way to predict who is at risk for hearing loss. Sound pressure, frequency, and length of exposure all determine whether what you hear is harmful or just annoying. However, the following are signs that noise may be a problem where you work:

- You have to shout to make yourself heard during work
- You have ringing in your ears for several hours after you leave work
- You have difficulty hearing normal sounds for several hours after you leave work.

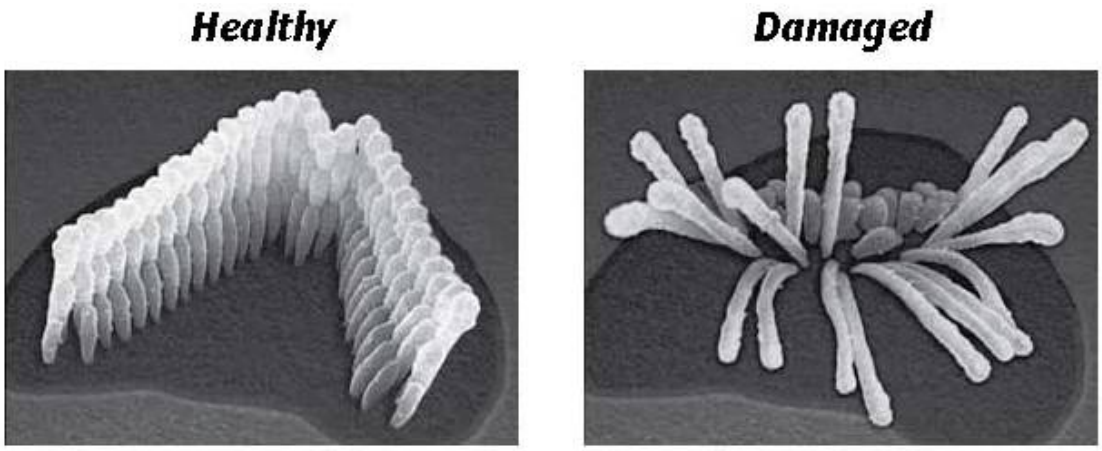
Most hearing specialist agree: You can damage your hearing if you're continually exposed to noise greater than 85 decibels over eight hours. As noise levels rise above 85 decibels, the safe exposure time for unprotected ears falls dramatically. For example, 110-decibel noise can impair hearing after just 15 minutes of exposure.

Gun Fun

The sound of a shotgun or a high-power rifle (about 140 decibels) is equal to about 40 hours of continuous exposure at 90dBA. Shooting 50 shotgun shells without hearing protection is equivalent to working in a 90-dBA environment for one year. An avid target shooter can produce one year's worth of noise exposure in just a few minutes!

How does sound damage hearing?

Very loud sounds can damage the sensitive hair cells in your inner ear. Hair cells are the foot soldiers for your hearing. As the number of damaged hair cells increases, your brain receives fewer impulses to interpret as sound. When you damage hair cells, you damage hearing.



Source: 'Dangerous Decibels Program' OHSU — www.dangerousdecibels.org

Repeated exposures to loud noise can damage hair cells to the point that they won't recover.

While a single exposure to loud noise can damage your hair cells, it probably won't destroy them. You may experience ringing in your ears and some sounds may be muffled, but your hair cells will recover and so will your hearing. This is called a **temporary threshold shift**.

But repeated exposures to loud noise can damage hair cells to the point that they won't recover. Because the damage is permanent, the result is called a **permanent threshold shift**. No treatment will restore it. When you destroy hair cells, you destroy hearing.

Noise adds up

Lower noise exposure levels may actually be riskier than higher levels. For example, exposures below 95 dBA may seem annoying but not loud enough for hearing protection, yet cumulative exposure can lead to hearing loss. Noise levels above 100 dBZ, however, are uncomfortable and discomfort serves as a reminder: Wear hearing protectors.

How to know if your hearing is damaged

Hearing loss is painless and gradual. It usually develops over several years – you might not even notice the loss during those years. Sometimes, overexposure to loud noises can trigger ringing or other sounds in your ears, called **tinnitus**. While tinnitus may be a symptom of damaged hearing, it can also be caused by infections, medications, and earwax.

The only way to know for sure if noise has damaged your hearing is to have a hearing examination by a certified audiometric technician, audiologist, otolaryngologist, or physician.

If you answer "yes" to any of the following questions, your hearing may be at risk:

- Do you frequently ask people to repeat sentences?
- Do you feel your hearing is not as good as it was 10 years ago?
- Have family members noticed a problem with your hearing?
- Are you exposed to loud noise without hearing protection where you work?
- Do you have to shout to a co-worker because of the noise around you?
- Are you exposed to noise from firearms, motorcycles, snowmobiles, power tools, or loud music without hearing protection?

When is workplace noise dangerous?

There's only one way to know. Have the noise evaluated by someone trained to conduct a **sound survey**. Anyone trained to use a sound-level meter and a dosimeter and evaluate the data should be able to do the survey. There are three basic types:

- ***Area monitoring.*** Use a sound-level meter and a dosimeter to estimate an individual's daily noise exposure.
- ***Personal monitoring.*** Use a sound-level meter and a dosimeter to estimate an individual's daily noise exposure.
- ***Engineering survey.*** Measure noise levels produced by machinery in different operating modes to find ways to eliminate or control the noise.

An effective noise survey should give you enough information to understand a noise problem – to identify it and to determine how to control it. But it's important to narrow the survey's focus so that you aren't overwhelmed with more information than you need to make a good decision.

Do you need a hearing conservation program?

Our hearing protection rule, 1920.95, Occupational noise exposure, says that your workplace must have a hearing conservation program when employees are exposed to noise levels that are equal to or grater than 85 dBA averaged over eight hours. The basic elements of the hearing conservation program include:

- Exposure monitoring
- Audiometric testing
- Hearing protection
- Employee training
- Recordkeeping
- Access to information

When other controls and hearing protectors are required

If your workplace has noise levels that are greater than those shown in the table below, you must use engineering or administrative controls to reduce employee exposures. If these controls aren't effective, your employees must also use hearing protectors to reduce their exposures to safe levels.

When engineering or administrative controls are required

Hours of exposure	*Sound level (dBA)*
8.0	90
6.0	92
4.0	95
3.0	97
2.0	100
1.5	102
1.0	105
0.5	110
0.25 or less	115

This requirement applies to all exposed employees, including those with hearing impairments. Even employees who have been diagnosed with severe or profound deafness may have some residual hearing, which must be protected.

About engineering controls

When you replace a noisy machine with a quiet one, modify it to make it quieter, or change the sound path so that the noise never reaches the listener, you're using an engineering control.

Workplace safety and health specialist will tell you that engineering controls are the best way to control noise. That's true only if the engineering control is effective, practical, and affordable. Applying engineering controls to a noise problem can be challenging because ready-to-order solutions may not be available. You're more likely to find a workable solution when you:

- Understand what's causing the noise
- Determine how the noise is reaching the worker
- Identify where to control the noise: at the source, along the sound path, or at the worker

Creative engineering solutions may also be the best ones. Here are three examples.

Build and enclosure: Construction workers were using a concrete mixer to de-grease metal parts by tumbling them in sawdust – effective but noisy. To reduce the noise level to below 85 decibels, the employer built an enclosure around the mixer with two-by-fours and an acoustic sound board, sealing the access door with polyurethane foam. The cost was minimal and the design was effective, it lowered noise levels to a safe 78 decibels.

Increase the distance: When you double the distance between the worker and the sound source, you decrease the sound pressure level by six decibels. For example, a hazardous 96-decibel noise source at five feet is a safe 84 decibels at 20 feet as show on the table below.

When engineering or administrative controls are required

Distance	*Decibel level at the source*	*Decibel level at the listener*
5 feet	96	96
10 feet	96	90
20 feet	96	84

This requirement applies to all exposed employees, including those with hearing impairments. Even employees who have been diagnosed with severe or profound deafness may have some residual hearing, which must be protected.

About administrative controls

Unlike engineering controls, which keep hazardous noise from reaching a worker, administrative controls change workers' activities to lower their exposure. Closely related to administrative controls are **work-practice controls**, which emphasize safe practices. Administrative and work-practice controls are usually less expensive than engineering controls because there is no cost in changing or modifying equipment. However, administrative and work-practice controls usually aren't as effective as engineering controls because they don't control the noise. Noisy machines are still noisy and the exposure is still present.

Examples of administrative and work-practice controls:

Administrative controls

- Reduce the time workers spend in noisy areas; rotate two or more workers so that each is exposed to noise less than 85 decibels, averaged over an eight hour day.
- Shut down noisy equipment when it's not needed for production.

Work-practice controls

- Maintain equipment so that it runs smoothly and quietly.
- Ensure that workers know how to perform their tasks and operate equipment at safe noise levels.
- Use warning signs to identify work areas where noise exceeds safe levels.

If an administrative control won't reduce employee exposures to safe levels, you'll need to consider a third noise-control tool: Hearing protectors.

About hearing protectors

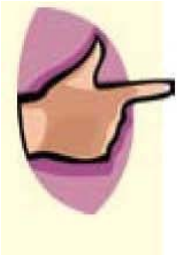
There are two types of hearing protectors: earplugs and earmuffs. They're the next line of defense against noise when you can't reduce exposures with engineering or administrative controls.

Earplugs fit in the outer ear canal. To be effective, they must totally block the ear canal with an airtight seal. They're available in different shapes and sizes and can be custom made. An earplug must be snugly fitted so that it seals the entire circumference of the ear canal. An improperly fitted, dirty, or worn-out plug will not seal and can irritate the ear canal.

Earmuffs fit over the entire outer ear – they won't fit properly over eyeglasses or long hair – and are held in place by an adjustable headband. The headband must hold the earmuff firmly around the ear.

Effectiveness: Better earplugs and earmuffs are about equal in sound reduction, though earplugs are more effective for reducing low-frequency noise and earmuffs for reducing high-frequency noise. Using earplugs and muffs together increases protection against higher noise levels (above 105 decibels) than either used alone.

Selecting hearing protectors: Focus on the three Cs: comfort, convenience, and compatibility. Employees won't wear hearing protectors that are uncomfortable or difficult to use or that interfere with their work. They should be able to choose, with the help of a person trained in fitting hearing protectors, from among a variety of appropriate types and sizes.



Most hearing protectors are labeled with a noise reduction rating (NRR) indicating a protection level in decibels, shown below. However, these ratings are not reliable outside of a testing laboratory, which is where they received the rating. The NRR rating tends to overestimate the protection a hearing protector will provide under real world conditions.

One way to estimate the real-world effectiveness of a hearing protector is to subtract seven dB from the manufacturer's NRR as shown in the example below:

You'll find the following method and others for estimating hearing protector effectiveness in Appendix B of our hearing protection rule, 1910.95, Occupational Noise Exposure rule.

Example: A hearing protector with an NRR value of 25	
1. Noise level to which the worker is exposed (averaged over eight hours).	95 decibels
2. NRR shown on the hearing protector label.	25 decibels
3. Subtract seven decibels from the NRR.	25-7 = 18
4. Subtract 18 decibels from 95 decibels.	95-18 = 77
This hearing protector may be able to reduce a worker's exposure from 95 decibels to 77 decibels.	

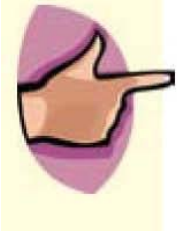
Elements of a hearing conservation program

Our hearing protection rules, 1910.95, Occupational noise exposure, requires your workplace to have a hearing-conservation program if your employees are exposed to noise levels that are equal to or greater than 85 dBA averaged over eight hours. The program's key elements are:

- Exposure monitoring
- Audiometric testing
- Hearing protection
- Employee training
- Recordkeeping
- Access to information

Exposure monitoring

Exposure monitoring can help you determine where it's too loud, when it's too loud, whose hearing may be at risk, and the level of hearing protection employees may need. There are two types: personal monitoring and area monitoring. **Personal monitoring** measures sound levels near individual workers, usually over eight hours.



An exposure weighted to account for time and changing noise levels over eight hours is called an ***eight-hour time-weighted average.***

Area monitoring measures sound levels at different locations in the workplace, usually at a single point in time. A dosimeter is generally used for personal monitoring while a sound-level meter is used for area monitoring.

Employees must have the opportunity to observe exposure monitoring and must be notified about the results if they are exposed at or above the 85-dBA limit.

Conduct monitoring whenever there's a change in your workplace – a production process or equipment change, for example – that may raise noise levels above the 85-dBA limit.

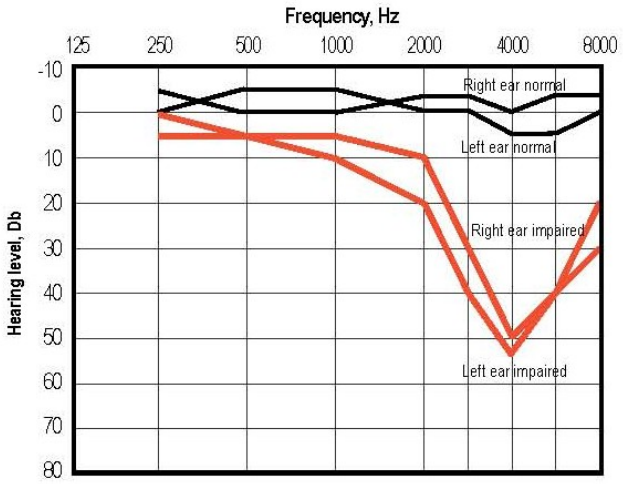
Audiometric testing

Audiometric testing determines whether an employee's hearing is stable or getting worse over time. The testing instrument is called an **audiometer** and the result of the test is an **audiogram**, a graph that shows an employee's hearing ability at different frequency levels.

An employee's **baseline audiogram** establishes a reference point for future audiograms. Those who are exposed to noise above 85 dBA averaged over an eight-hour day must have baseline audiograms within six months of their first exposure.

Employees must be retested at least annually if they are still exposed above the 85-dBA limit. The results of each employee's annual audiogram must be compared with the baseline audiogram to determine if the employee's hearing has changed. If the comparison indicates a change in an employee's hearing – called a **standard threshold shift** – the employee must be notified within 21 days of the finding. Then, you must either accept the test results or retest the employee within 30 days.

- Any employee who has a standard threshold shift and who is not using hearing protectors must be fitted with them, trained to use them, and required to use them.
- Any employee who has a standard threshold shift and has been wearing hearing protectors must be refitted and retrained.
- Only a certified audiometric technician, audiologist, otolaryngologist, or physician can perform an audiometric test.



Example of an audiogram showing normal and impaired hearing

Hearing protection

You must provide employees with hearing protectors at no cost if they are exposed to workplace noise that equals or exceeds 85 dBA, averaged over eight hours. They must be able to select them from a variety of types that are compatible with their work tasks. Employees must also be properly fitted and trained to use and care for their hearing protectors.

Training employees

Employees who are exposed to noise levels greater than 85 decibels must have annual training that teaches them why sustained 85-decibel noise can damage their hearing, the purpose of audiometric testing, why they should use hearing protectors, and how to use them properly.

Recordkeeping

Keep records of all exposure monitoring and audiometric tests. Audiometric test results must include the employee's name and job classification, audiogram date, examiner's name, date of the audiometer's most recent acoustic or exhaustive calibration, and the employee's most recent noise exposure assessment. Records must also include information on background noise levels in the audiometric test booth.

Recording hearing loss on the OSHA 300 log: You must record an employee's hearing loss on the OSHA 300 log if an annual audiogram shows a standard threshold shift in either ear and the hearing level in the ear is 25 decibels above **audiometric zero**. If a physician or other licensed health care professional determines that the hearing loss isn't work-related or aggravated by workplace noise, the you don't need to record it.

Access to information

Our hearing protection rule, 1910.95, Occupational noise exposure, must be posted at your workplace where employees can see it. Employees must also have access to their exposure monitoring records for at least two years and their audiometric test records for the duration of their employment.

Vermont Department of Labor

Project Work*SAFE*

We can help!
If you are a Vermont business with less than 250 employees, there are FREE and confidential services available to you – anything from a phone consult to a full safety and health evaluation at your worksite. Just call Project Work*SAFE* at the Vermont Department of Labor.

We give FREE, NO-PENALTY consultations
At your request, we will go with you on a tour of your facility, point out problem areas and help you to identify and implement solutions. Our services include safety audits, program development and evaluation, chemical exposure assessments and noise monitoring.

You can protect your employees
Learning more about workplace hazards and how to prevent them can help you protect your workers from injury and illness. It may even prevent loss of life at your worksite.

It's good for business
Effective workplace safety and health practices are good business. The cost of an accident or lost work time can far exceed the cost of prevention.

For more information about Project Work*SAFE*:
1-888-SAFE-YES
www.labor.vermont.gov
Equal Opportunity is the Law

Project Work*SAFE*'s quick guide to hearing protection
Oregon OSHA 440-3349 (2/10/COM)