Oregon OSHA's quick guide to hearing protection

What you should know and not a word more!

Oregon OSHA

A Division of the Department of Consumer and Business Services

About this guide

Oregon OSHA quick guides are for employers and employees who want to know about our requirements and get back to business quickly.

Who should read this guide?

Read this guide if you want to:

- Understand how workplace noise affects hearing.
- Learn the key requirements of our hearing protection rule **1910.95, *Occupational noise exposure***. This rule covers general industry, construction, and forest activities workplaces.

We want you to understand what you read

Every ***Oregon OSHA quick guide*** comes with a **plain-language guarantee**! Let us know if you're not satisfied. Contact Ellis Brasch at **ellis.k.brasch@state.or.us**.

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Contents

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 does not 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. In this guide, **noise** means sound that interferes with one's hearing. We are 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 cannot be cured, but it can be prevented.

What is sound and how is it measured?

Sound is a wavelike vibration that travels through air or another medium. Units called **decibels** measure the intensity of sound. The frequency of a sound – the number of wavelike vibrations per second – is measured in units called **hertz** (Hz). A sound's **pitch** is how you perceive its frequency; the higher the pitch, the higher the frequency.

Human hearing is most sensitive to frequencies between 3,000 and 4,000 Hz. That is why people with damaged hearing often 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 (20,000 Hz).

Sound-measuring instruments

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

A sound-level meter measures decibels in a specific area at a moment in time – good for estimating noise exposure in areas where noise levels are relatively constant and workers are not mobile. A dosimeter measures decibels over the time that the dosimeter is on, such as an eight-hour day.

Sound-level meter

Measures noise at a moment in time.

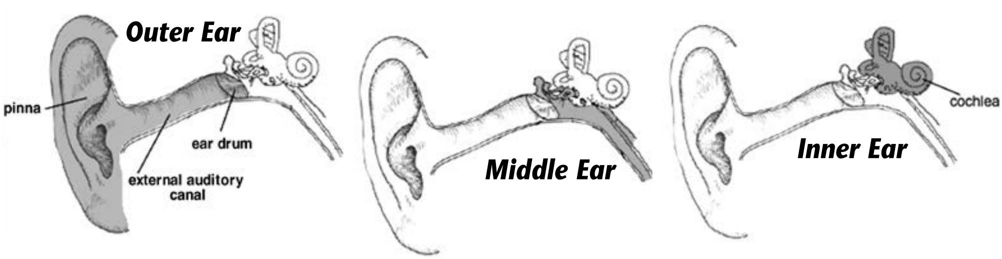
Dosimeter

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.

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 **cilia**, or **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?

Sound pressure, frequency, and the length of exposure all determine whether what you hear is harmful or just annoying. 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 after you leave work
- You have difficulty hearing normal speech and other sounds after work

Most hearing specialists agree: You can damage your hearing if you are 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.

Do you know your dBAs and dBCs?

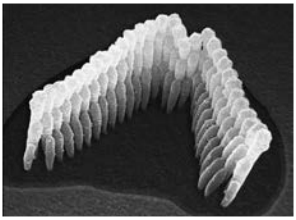
Sound-level meters and dosimeters measure decibels in different frequency ranges, typically a dBA scale and a dBC scale. The dBA scale reflects measurements that emphasize higher frequencies, closer to human hearing. The dBC scale measures the lower frequencies in the environment, which our ears don't perceive as very loud. We may not hear the lower frequencies, but we can feel them.

How does sound damage hearing?

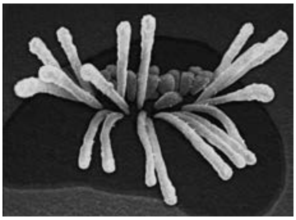
Very loud sounds can damage the sensitive hair cells in your inner ear. As the number of damaged hair cells increases, your brain receives fewer impulses to interpret as sound. When you damage hair cells, you damage hearing.

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

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**. Currently, there are no treatments that can restore noise-induced hearing loss.



Healthy



Damaged

How to know if your hearing is damaged

Hearing loss is usually painless and gradual. It may develop over several years and you might not even notice the loss during those years. Sometimes, overexposure to loud noise can trigger ringing or other sounds in your ears, called **tinnitus**. (Tinnitus may also be caused by infections, medications, or other conditions.)

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

Risk factors for hearing loss include:

- Exposure to loud noise where you work (without hearing protection)
- Exposure to noise from firearms, motorcycles, snowmobiles, power tools, or loud music (without hearing protection)
- Exposure to chemicals such as aromatic solvents or metals such as lead, arsenic, and mercury

Are you showing any of these signs of hearing loss?

- You frequently ask people to repeat sentences or to speak up.
- You have difficulty following conversations in public places.
- Friends or family members have noticed a problem with your hearing.
- People often ask you to speak more softly.

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 to identify areas in the workplace that may put workers' hearing at risk.
- ***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 sound survey should give you enough information to understand a noise problem — to identify it and determine how to control it. But it is important to narrow the survey's focus so that you are not overwhelmed with more information than you need to make a good decision.

There is also evidence that long-term noise exposure may contribute to stress-related disease, especially cardiovascular disease.

When engineering controls, administrative 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 controls** or **administrative controls** to reduce employee exposures. This applies to all exposed employees, including those with hearing impairments.

If these controls are not enough, your employees must also use hearing protectors to reduce their exposures to these levels.

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

Exposures below 95 dBA may seem annoying and not loud enough for hearing protection, yet cumulative exposure can lead to hearing loss. Noise levels above 100 dBA, however, are uncomfortable and the discomfort serves as a reminder to protect your hearing.

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 are using an engineering control.

Workplace safety and health specialists will tell you that engineering controls are the best way to control noise. That is 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 are more likely to find a workable solution when you:

- Understand what is 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 two examples.

Build an enclosure: Construction workers were using a concrete mixer to degrease 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: By increasing the distance between the worker and the sound source, you can significantly decrease the sound pressure level. For example, a hazardous 96-decibel noise source at 5 feet from the listener is a safer 84 decibels at 20 feet.

About administrative controls

Unlike engineering controls, which eliminate the source of the noise or separate it from workers, administrative controls change workers' activities and emphasize policies that can lower their exposure. Administrative controls are usually less expensive than engineering controls because there are no costs to replace or modify equipment. However, administrative controls usually are not as effective because they do not eliminate the source of the noise.

How to use administrative controls:

- Reduce the time workers spend in noisy areas; rotate two or more workers so that each is exposed to less noise for shorter periods of time.
- 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.
- Maintain equipment so that it runs smoothly and quietly.
- Shut down noisy equipment when it is not needed for production.
- Consider how much noise that equipment will produce before purchasing or renting.

About hearing protectors

There are two types of hearing protectors: **earplugs** and **earmuffs**. They are the next line of defense against noise when you cannot 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 are 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 will not fit properly over glasses 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 earmuffs 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 will not wear hearing protectors that are uncomfortable, difficult to use, or 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 decibels from the manufacturer's NRR as shown in the example below:

You will find this method and others for estimating hearing protector effectiveness in *Appendix B* of Oregon OSHA's 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.	

Do you need a hearing conservation program?

Oregon OSHA's hearing protection rule, ***1910.95, 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 greater than 85 dBA averaged over eight hours. The basic elements of a hearing conservation program, which are described below, include:

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

Exposure monitoring

Exposure monitoring can help you determine where it is too loud, when it is 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.

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.

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

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 a change in your workplace – a production process or equipment change, for example – 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.

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.

For more information see, *About hearing protectors*, page 10.

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** – the lowest sound pressure level that a young adult can hear. If a physician or other licensed health care professional determines that the hearing loss is not work-related or aggravated by workplace noise, then you do not need to record it.

Access to information

Oregon OSHA's 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.

A noise compliance quiz

Do you have an effective hearing conservation program? Take this quiz to find out. (All your answers should be "yes.")

1.	Have you conducted a noise survey to find out if your workplace has work processes or equipment that equal or exceed 85 dBA averaged over eight hours?	Yes	No
2.	If your workplace has noise levels that equal or exceed 85 dBA averaged over eight hours, have you started a hearing conservation program?	Yes	No
3.	If you have a hearing conservation program, are hearing protectors available at no cost to affected employees?	Yes	No
4.	Do employees use hearing protectors that, at a minimum, reduce workplace noise levels below 90 dBA?	Yes	No
5.	If you have a hearing conservation program, do the employees understand the effects of noise on hearing, the purpose of hearing protectors and how to use them, and the purpose of audiometric testing?	Yes	No
6.	Have the employees who are exposed to noisy work processes or equipment had personal exposure monitoring to determine their eight-hour time-weighted averages?	Yes	No
7.	If your workplace has noise levels that equal or exceed 90 dBA averaged over eight hours, are you using engineering or administrative controls to lower employee noise exposure?	Yes	No

8. Are your employees allowed to observe exposure monitoring?	Yes	No
9. Do you notify your employees if their exposure-monitoring results indicate they are exposed at or above 85 dBA averaged over eight hours?	Yes	No
10. Do you repeat exposure-monitoring when there are changes at your workplace that may affect noise levels?	Yes	No
11. Do you keep your employees' noise exposure-monitoring records for at least two years?	Yes	No
12. Do you provide baseline and annual audiometric testing for employees in your hearing conservation program?	Yes	No
13. Do you make sure that your employees are not exposed to workplace noise for at least 14 hours before their audiometric tests?	Yes	No
14. Does a licensed or certified technician, audiologist, otolaryngologist, or physician perform employees' audiometric tests?	Yes	No
15. Do you keep your employees' audiometric test records for the duration of their employment?	Yes	No
16. Do you have a copy of Oregon OSHA's *Occupational Noise Exposure rule, 1910.95*, available for employees to review?	Yes	No

Important terms

Administrative control. A method of controlling workplace hazards by changing workers' activities to reduce their exposure.

Audiometer. An instrument used to conduct hearing tests.

Area monitoring. An exposure-monitoring method that measures sound levels at different locations in the workplace, usually at a single point in time.

Audiogram. A graph that shows the softest sounds that a person can hear at different frequencies.

Audiometric zero. The lowest sound pressure level that the average young adult with normal hearing can hear.

Baseline audiogram. The reference audiogram against which future audiograms are compared.

Cilia. Sensory cells in the inner ear that transform the mechanical energy of sound into nerve impulses.

Decibel (dB). The unit of measurement for sound level. Sound pressure is measured in units on a logarithmic scale.

Dosimeter. A device worn by a worker that measures sound pressure over a period of time to determine noise exposure.

Earmuffs. Personal protective equipment that fits over both ears and forms a tight seal.

Earplugs. Personal protective equipment that fits snugly in the outer ear canals. To be effective, an earplug must block air from entering the ear canal.

Eardrum. A membrane in the ear canal between the outer ear and the middle ear.

Eight-hour time-weighted average. An average exposure adjusted to account for time and changing levels of exposure over an eight-hour work day.

Engineering control. A method of controlling a workplace hazard by modifying or eliminating the source of exposure so that it is no longer hazardous.

Frequency. The number of sound vibrations in one second, measured in hertz (Hz).

Hair cells. See Cilia.

Hearing conservation program. Required by Oregon OSHA for workplaces where employees are exposed to noise levels at or above 85 decibels averaged over eight hours. Program elements include exposure monitoring, audiometric testing, hearing protector use, employee training, access to information, and recordkeeping.

Hearing protectors. Personal protective equipment that decreases the pressure of sound that reaches the eardrum; includes earplugs and earmuffs.

Hertz (Hz). Unit of measurement of frequency, numerically equal to cycles per second.

Inner ear. The inner portion of the ear that contains sensory organs for hearing and balance.

Logarithmic scale. A scale that expresses values over a very large range. Each interval on a logarithmic scale is some common factor larger than the previous interval. A typical factor is 10; the values on such a scale read: 1, 10, 100, 1,000, 10,000, and so on.

Middle ear. The middle portion of the ear that connects the eardrum to the inner ear and changes sound waves into a mechanical vibration.

Noise. Sound that is noticeably unpleasant, undesired, or that interferes with hearing.

Noise-induced hearing loss. The result of exposure to sound of sufficient intensity and duration to cause a decrease in hearing ability.

Outer ear. The external portion of the ear that gathers sound vibrations and guides them into the ear canal.

Permanent threshold shift. A type of noise-induced hearing loss. A permanent decrease in the ability to hear at a specified frequency as compared with a previously established reference level.

Personal monitoring. A method of measuring sound levels near individual workers, usually over eight hours.

Pitch. The property of a sound determined by the frequency of the waves that produce it; the highness or lowness of sound.

Sound. The subjective sensation of hearing something – usually vibration transmitted in air. Sound pressure is measured in decibels.

Sound-level meter. An instrument that uses a microphone, amplifier, and output meter to measure sound pressure levels.

Sound survey. A variety of methods for measuring sound levels, including environmental (workplace) surveys and worker exposure levels over a period of time, such as an eight-hour work day.

Standard threshold shift. A type of noise-induced hearing loss. As defined by OSHA, a change in the hearing threshold relative to the baseline audiogram of an average of 10 dB or more in either ear at 2,000, 3,000, and 4,000 Hz.

Temporary threshold shift. A type of noise-induced hearing loss. A temporary, reversible impairment of hearing ability.

Tinnitus. Ringing in the ear or noise sensed in the brain. Onset may be due to excessive sound exposure and persist in the absence of acoustical stimulation.

*Oregon*OSHA Services

Oregon OSHA offers a wide variety of safety and health services to employers and employees:

Consultative Services

- Offers no-cost, on-site safety and health assistance to help Oregon employers recognize and correct workplace safety and health problems.
- Provides consultations in the areas of safety, industrial hygiene, ergonomics, occupational safety and health programs, assistance to new businesses, the Safety and Health Achievement Recognition Program (SHARP), and the Voluntary Protection Program (VPP).

Enforcement

- Offers pre-job conferences for mobile employers in industries such as logging and construction.
- Inspects places of employment for occupational safety and health hazards and investigates workplace complaints and accidents.
- Provides abatement assistance to employers who have received citations and provides compliance and technical assistance by phone.

Appeals, Informal Conferences

- Provides the opportunity for employers to hold informal meetings with Oregon OSHA on concerns about workplace safety and health.
- Discusses Oregon OSHA's requirements and clarifies workplace safety or health violations.
- Discusses abatement dates and negotiates settlement agreements to resolve disputed citations.

Standards and Technical Resources

- Develops, interprets, and provides technical advice on safety and health standards.
- Provides copies of all Oregon OSHA occupational safety and health standards.
- Publishes booklets, pamphlets, and other materials to assist in the implementation of safety and health standards and programs.
- Operates a Resource Center containing books, topical files, technical periodicals, and a video lending library.

Public Education and Conferences

- Conducts conferences, seminars, workshops, and rule forums.
- Coordinates and provides technical training on topics such as confined space, ergonomics, lockout/tagout, and excavations.
- Provides workshops covering management of basic safety and health programs, safety committees, accident investigation, and job safety analysis.
- Manages the Safety and Health Education and Training Grant Program, which awards grants to industrial and labor groups to develop training materials in occupational safety and health for Oregon workers.

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