

An introduction to OR-OSHA's rule for controlling noise in the workplace

HEARING CONSERVATION PROGRAM



Sound
Sound
Sound
Sound
Sound
Basics



Presented by the Public Education Section
Department of Business and Consumer Business
Oregon OSHA



OR-OSHA Mission Statement

To advance and improve workplace safety and health for all workers in Oregon.

Consultative Services

- Offers no-cost on-site safety and health assistance to help Oregon employers recognize and correct safety and health problems in their workplaces.
- Provides consultations in the areas of safety, industrial hygiene, ergonomics, occupational safety and health programs, new-business assistance, 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.
- Provides abatement assistance to employers who have received citations and provides compliance and technical assistance by phone.
- Inspects places of employment for occupational safety and health rule violations and investigates workplace safety and health complaints and accidents.

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

Standards & Technical Resources

- Develops, interprets, and provides technical advice on safety and health standards.
- Provides copies of all OR-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, a video and film lending library, and more than 200 databases.

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- Conducts conferences, seminars, workshops, and rule forums.
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Welcome

Welcome to the Hearing Conservation workshop. This workshop is designed to include you in the learning experience. The more you contribute, the more you will get out of this training, so please don't hold back...participate and have fun!

Purpose

OR-OSHA requires that an employer monitor noise in a workplace and that appropriate hearing protection be furnished to the employee when required under the rule.

The purpose of this workshop is to give you the basic knowledge needed to understand why hearing conservation is an important part of the safety and health equation.

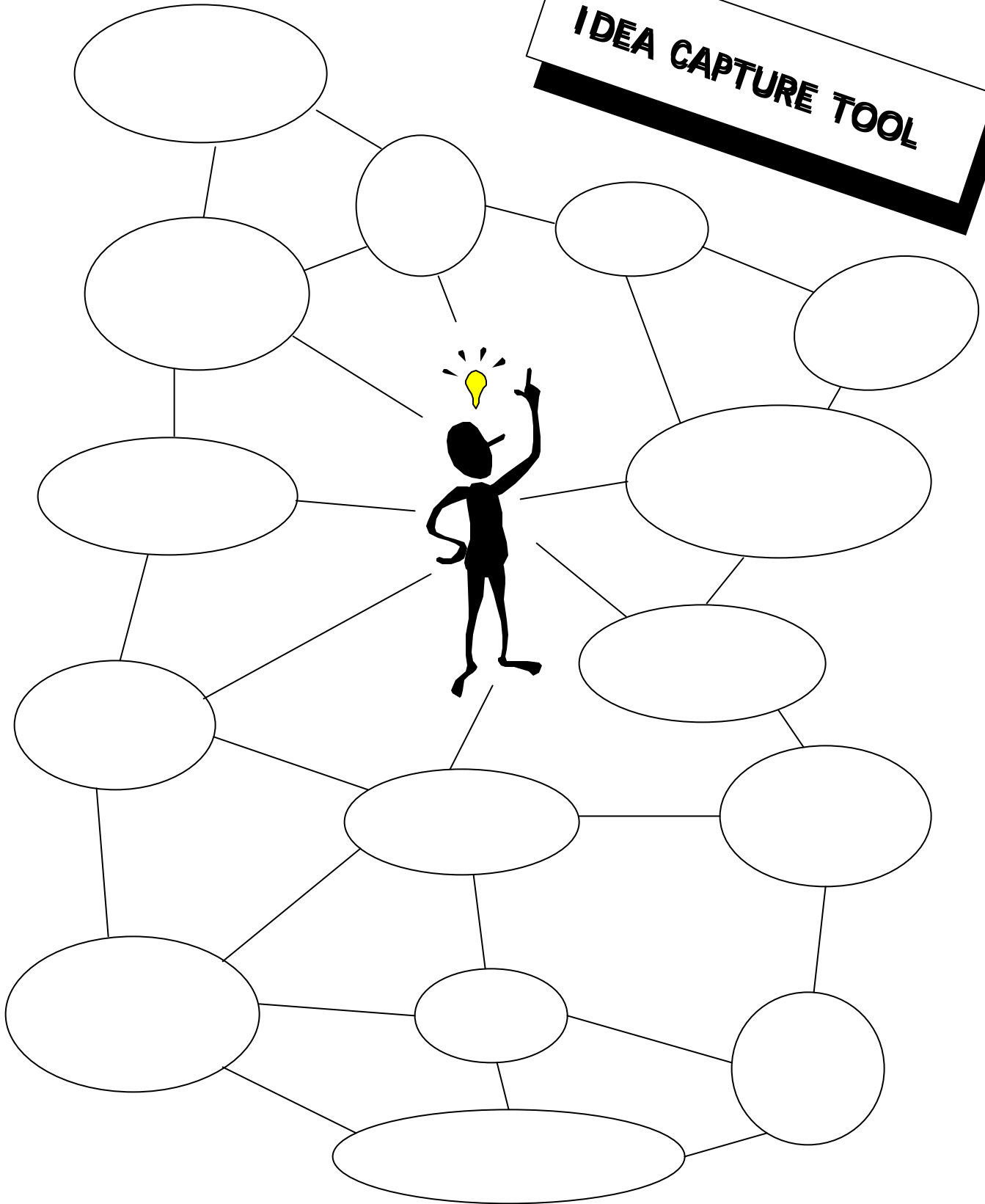
Objectives:

By the end of this presentation, participants should be able to...

1. Explain how sound is created
2. Describe how the ear receives and interprets sound
3. Name two ways sound is measured
4. Describe at least two indicators of excessive noise in a workplace
5. Name the part of the ear damaged by excessive noise and the medical test used to document that damage
6. Identify five key elements of a hearing conservation program

Please Note: This material or any other material used to inform employers of compliance requirements of Oregon OSHA standards through simplification of the regulations should not be considered a substitute for any provisions of the Oregon Safe Employment Act or for any standards issued by Oregon OSHA.

IDEA CAPTURE TOOL



Part One: A Sound Review

- So, What's the Problem?
- How is Sound Created?
- How do We Hear Sound?
- Measuring the Sound We Hear
- How Much is Too Much?

So, What's the Problem?

In a word, **NOISE**...too much of it! As our world has become more mechanized, the problem of noise pollution also has increased. Noise bombards us around the clock, at work, home and play.



What is Noise?

The terms **Noise** and **Sound** often are used interchangeably. One person's music can be another's racket. So let's see if we can agree on a working definition for today's discussion:

Sound can be _____, or _____.

In terms of occupational health, noise can be defined as any sound that is intense enough to...

_____ hearing.

Noise is a **BIG** Problem!

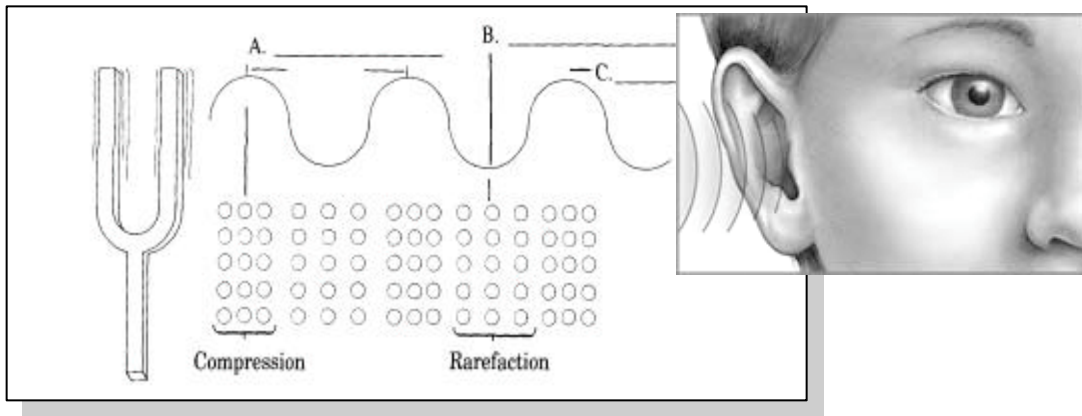
Noise, or unwanted sound, is one of the most pervasive occupational health problems. Occupational hearing loss is the **number one cause** of nonfatal health problems in the U.S. Over 28 million people are affected with partial or total hearing loss.

It's a sneaky villain, too. Each over-exposure to noise sources such as heavy equipment, air compressors, powder-actuated fasteners, radial saws, etc., can damage some of the thousands of delicate nerve cells in your ears. Although the cells will try to repair themselves, repeated damage will eventually destroy them.

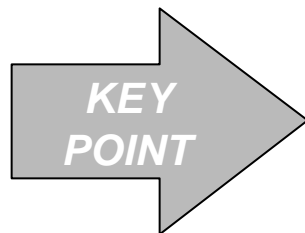
This destruction is so gradual it usually goes unnoticed, but the hearing loss is permanent.

How is Sound Created?

A vibrating body pushes on _____, creating a series of pressure waves that radiate out from the source of the vibration.



A sound wave is a series of these compressions and rarefactions traveling through a substance. The individual molecules do not travel; rather, they vibrate rhythmically back and forth.



Any
Vibrating Object + Any
Transmitting Medium = Sound
Wave

How Do We Hear Sound?

It's as simple as 1, 2, 3...

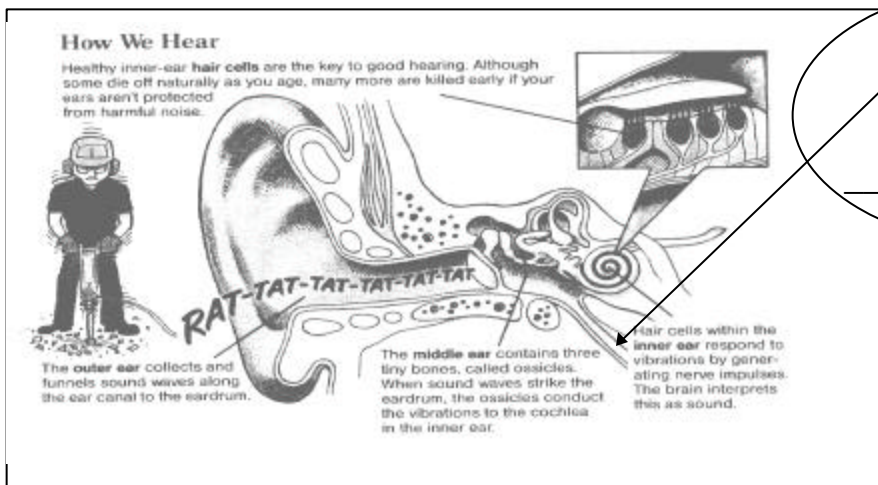
1) Your **outer ear** collects sound waves and channels them down the ear canal to a thin, tight piece of skin called the:

_____.

2) The eardrum vibrates in response to these pressure waves and pushes on the small bones of your **middle ear**. These bones act like a set of levers, transferring their mechanical motion to a fluid-filled structure in the **inner ear**, called the:

_____.

3) In the cochlea, cells with tiny sensing hairs transform the fluid movement into electrical signals. These signals travel along the auditory nerve to your brain. Once in the brain, the nerve signals are decoded and processed into what we recognize as sound.



This is what makes your ears "pop". We call it the _____ tube.

Now, for a few extra details about...

The Cochlea - It's the main organ of hearing, found in the fluid-filled inner ear. It's a snail-shaped tube that's very complex. It contains the _____, a ribbon-like structure that contains sensory cells with hairs projecting from them.

When the stirrup vibrates and bangs against the oval window, the fluid in the cochlea vibrates, and the organ of Conti shakes.

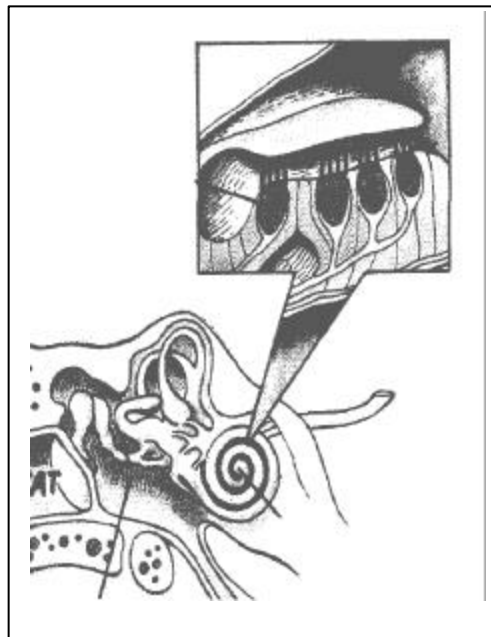
There are over _____ hair cells in the organ of Conti, and each of these cells has 50-100 hairs sticking out of it. The hair cells' movement stimulates the nerve cells, which in turn sends electrical impulses to the brain.

PICTURE THIS:

You take a shortcut across a luxuriant green lawn with tall, healthy blades of grass reaching proudly toward the sky. Where you have walked, the blades are trampled, bent over, bruised and damaged. You can see the outline of each of your steps in the thick carpet of grass.

Tomorrow, you decide to take the same shortcut. As you look, there is no sign you passed this way yesterday. This time, however, some of your co-workers see you and decide to do the same thing. Soon, many people begin taking this route, not just once a day but throughout the day as well.

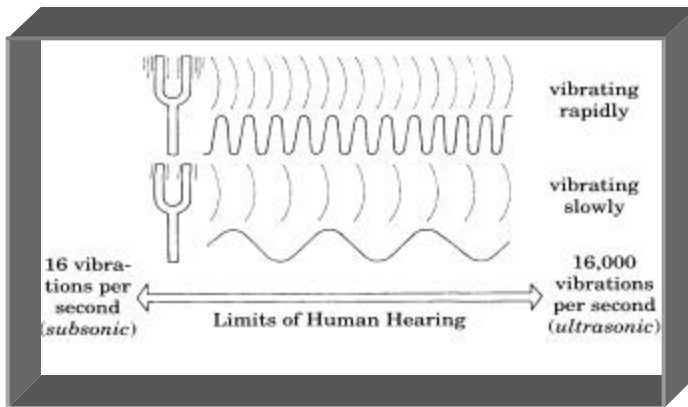
Before long, bicyclists are using the path. Eventually, the blades of grass have no time to repair themselves between uses. Gradually, some of the blades break off, and then more as time progresses. Eventually, where once there was a beautiful lawn, there now is a dirt trail with only a blade or two of grass here and there..



How is Sound Measured?

Once it's been created, a sound has **two** fundamental characteristics:

1)



A vibrating object pushes waves of air molecules away from itself each time it moves, which in most cases is many times or **cycles** every second. You might say it pushes the air **frequently**. Since some objects vibrate more frequently than others we tend to classify them according to their...

Frequency!

**A
Z
D
I
I
I**

2)

hint, hint...

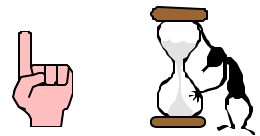
hint, hint...



Measuring Sound... Three Ways / Two Tools

We measure sound in three different ways:

- (1) **Frequency**, or pitch, is measured as sound vibrations per second or _____.
- (2) **Intensity**, or loudness, is measured in _____.
- (3) **Duration**, or how long the exposure lasts, is measured in good old familiar _____.



How Do You Know How Much Noise you're Exposed To?

There are **two measuring devices** used to test amounts of sound in any given situation:

1. Sound Level Meter

- Provides a snapshot
- Provides immediate results
- Measures the noise levels in the immediate area
- Measures loudness in decibels

2. Dosimeter

- Worn by the individual during the day
- Measures the sound near the entrance to the ear
- Measures the amount of noise encountered continuously as the individual goes about the day's work

Measuring Sound (continued)...

Measurement Scales

The OSHA Rule uses language that says..."equal or exceed...85 decibels **measured on the A scale** (slow response)". So what's that all about?

Various measurement scales treat intensity and frequency differently according to the purpose they are intended to serve. There are three scales it helps to know about:

- (1) dBC or linear scale
- (2) Octave band, or narrow band scale
- (3) dBA scale

The C scale takes the energy from all frequencies in the sound and treats it all equally.

The octave band reports only the energy from a single frequency.

The A scale treats each frequency differently, imposing a very high reference level on some low frequencies and a very low reference level on others. As a result, low frequencies are not given as much weight in a dBA measure.

We use the dBA scale because it most closely mimics the scale of human hearing and because damage is more likely to occur in the higher frequency ranges.

"Slow Response": This is a damper on the meter needle so that readings are averaged out when the sound levels are uneven.

How much is Too Much?

Once sound levels are determined, the figures must be adjusted to arrive at a **Time-Weighted Average (TWA)*** exposure.

The amount of sound you receive each day depends on three factors:

- 1) _____ measured in dBA's;
- 2) _____ of exposure;
- 3) _____ of exposure (the range of noise levels and frequencies);

Prolonged exposure to sound levels greater than _____decibels will result in hearing loss.

You don't "get used to" noise...

Noise does not have to be uncomfortably loud to be damaging.

You may even think your ears are "used to" the noise, but what has probably happened is that hearing loss has already begun.

* **Time-weighted average (TWA)** sound level defined:

That sound level, which if constant over an 8-hour exposure, would result in the same noise dose as is measured.

Taking Action for Hearing Health

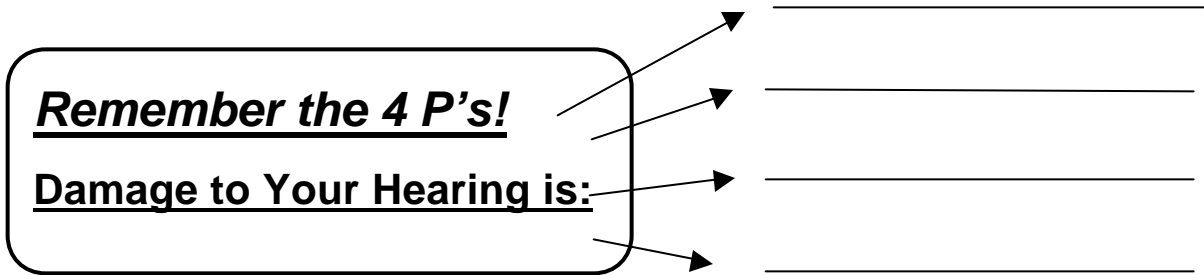
Why It's important To Act NOW...

Because every day you are exposed to noise, whether it's work-related or a part of your home and recreational environment, some damage is done to your ear's hair cells. It may be gradual, **painless**, and invisible, but.....

the damage is very real, it is **progressive**, and it is **permanent**.

Remember the 4 P's!

Damage to Your Hearing is:



Bonus Points for the fifth P.....

Action Steps You Can Take Now

- Wear hearing protection for hobbies, sports, hunting, etc.
- Voluntarily wear hearing protection at work.
- Learn proper nose-blowing technique.
- Seek medical attention if a cold becomes chronic.
- Control Walkman levels.

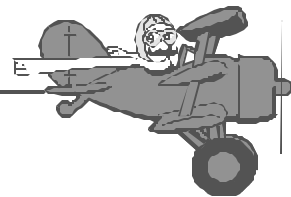
Part Two: Controlling Workplace Noise

- *Five components of a hearing conservation program*
- *What you should know about exposure monitoring*
- *What you should know about audiometric testing*
- *Using engineering controls*
- *Using administrative controls*
- *Using Hearing Protection Devices (HPD'S)*
- *What you should know about education and training*
- *Recordkeeping*

Five components of a Hearing Conservation Program

- (1) Monitor noise levels**
- (2) Perform audiometric testing**
- (3) Select appropriate Hearing Protection Devices (HPD's)**
- (4) Educate and train affected employees**
- (5) Do the Recordkeeping**

Let's talk specifics...



Requirement for Establishing a Hearing Conservation Program:

1. Monitor noise levels

Whenever an employer determines that workers are exposed to average noise levels of **85 dB or greater** during an **8 hour workday**. This numerical value is referred to as the: _____.



Monitoring isn't necessarily *required* under the OSHA rule; only when exposures are at or above _____..

So how can an employer decide whether or not a problem may exist?

QUICK TEST:

Do you have to shout to talk to someone 2-3 feet away?

Other indicators that noise levels could be excessive and that monitoring probably should occur:

- Employee complaints about the loudness of the noise;
- Indications that some employees are losing their hearing;
- Noisy conditions that make normal conversation difficult.

1. Monitoring (continued)

Your monitoring goals should be:

- To identify employees who should be included in the hearing conservation program;
- To enable the proper selection of hearing protection.

Requirements for monitoring include the following:

- Representative personal sampling may be necessary if there is high worker mobility or significant variations in the sound level throughout the work shift.
- Repeat monitoring must be performed whenever there is a change that increases exposure levels.
- Employees exposed at or above action levels must be notified of monitoring results.
- Affected employees or their representatives may observe the monitoring process.

Three Types of Noise that Monitoring must Address:

- 1.
- 2.
- 3.

2. Test Employee Hearing

In Oregon, audiometric testing may be performed by any of these three individuals:

1. _____
2. _____
3. A technician certified by the Council on Accreditation in Occupational Hearing Conservation.

For audiometric testing to be most effective, an employee should have a pre-employment or pre-placement audiogram to act as a baseline to which future audiograms will be compared.

The OSHA rule requires that this baseline audiogram be administered within _____ of an employee's first exposure at or above the action level.

Testing to establish a baseline audiogram shall be preceded by at least _____ hours without exposure to workplace noise.

T/F It's okay to use hearing protectors at the work site to achieve the 14 hours requirement, provided they give a sufficient level of protection.

2. Testing (continued):

Once the baseline audiogram is done, a new audiogram is required at least how often? _____

...for every employee who meets what requirement?

Exposed at or above the _____.

In comparing the baseline with annual audiogram results, the technician is looking for any evidence of a.....





Standard Threshold Shift

STS is defined as a change in the hearing threshold relative to the baseline audiogram of an average of _____ or more at 2,000, 3,000 and 4,000 Hz.

If the reviewer finds an STS exists, the employee must be informed in writing within what time period? _____ .

Managing Noise Exposure: Three Methods...

A. Engineering Controls

- a) Generally preferred as a first choice. However, these are a challenge in that there are seldom ready-to-order solutions. They must be tailored to the situation.
- b) In many instances it is difficult to achieve even 10dB of noise reduction in a retrofit noise control application.
- c) Many such controls require maintenance and periodic adjustment or replacement to remain effective.
- d) Works best when coupled with carefully selected **Hearing Protection Devices (HPD's)** and adequate emphasis on training, motivation, supervision and enforcement.

B. Administrative Controls

- a) Job Rotation
- b) Selective operation of equipment only when needed in the production process
- c) Ensuring employees maintain the equipment in good running order

C. Personal Protective Equipment (HPD's)

3. Selecting appropriate Hearing Protection Devices (HPD's)

Employers are required to provide hearing protectors to all employees who meet what requirement? _____ *

Hearing Protector Attenuation *

An employer must evaluate a selected hearing protection device for its ability to **attenuate** or reduce the amount of noise that actually reaches the eardrum. The employee must be provided with whatever combination of protection is required to achieve the following levels:

- a) Attenuation to an exposure level of _____ or less over an 8-hour TWA.
- b) For employees with an STS, exposure must be attenuated to an 8-hour TWA of _____ or less.

Key Point:

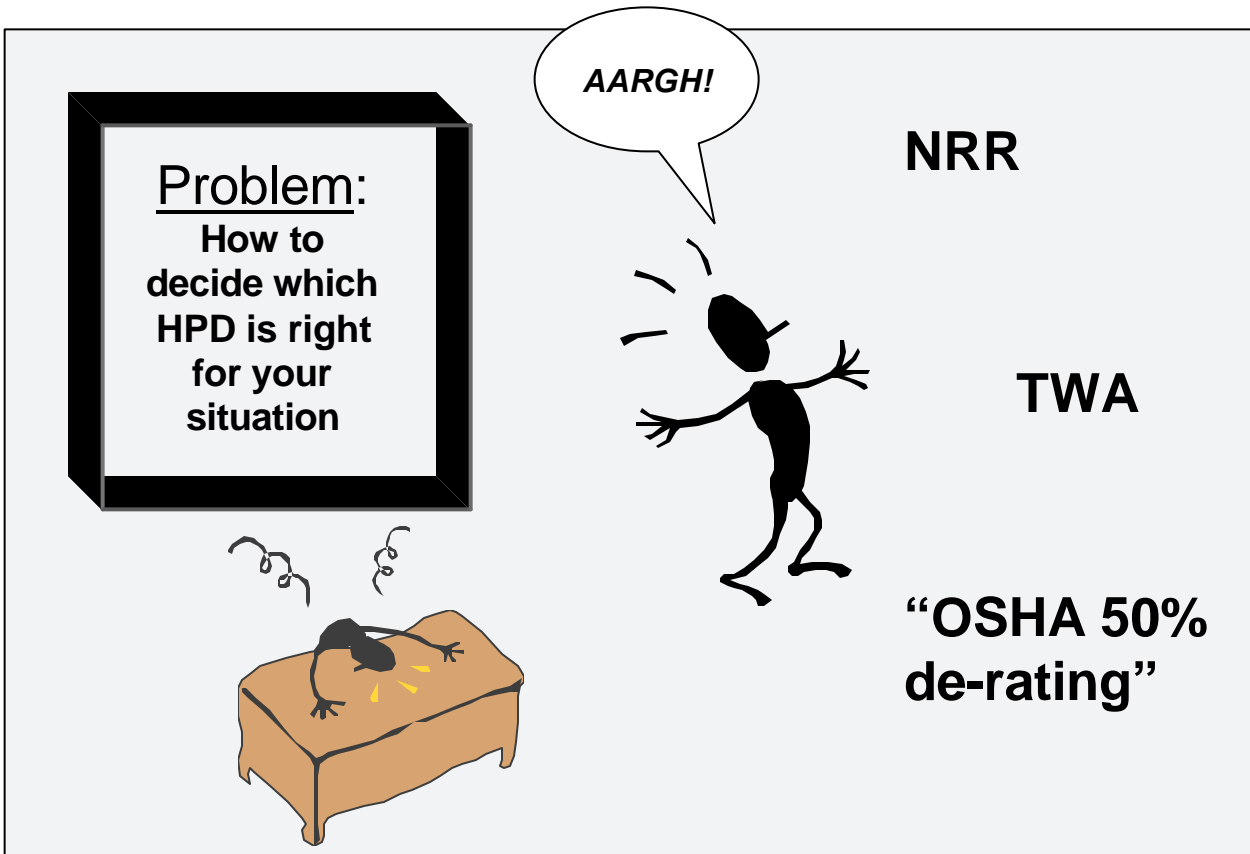
Remember that the ear is the only organ that has **no defense mechanism**. It's basically a straight shot from outside the ear to the eardrum and into the middle and inner ear. Whereas your eyelid can blink and protect the eye, your ear has to sit there and take the full force of a sound wave. That's why **you** are so essential to your ears' health!

* For additional information, refer to Appendix B, page G-33 of the Code.

Determining the adequacy of HPD attenuation


First, some points to consider:

- It's estimated that 97% of industries have TWA's below 100dB. Therefore, if one selects an HPD with 10dB of **actual** noise attenuation, the odds of being in compliance are 90%+.
- The average **Noise Reduction Rating (NRR)** for HPD's sold in North America today is over 22dB.
- It's vital that the employer consider factors such as comfort, compatibility, wearability, and employee satisfaction, in addition to the selected HPD's advertised level of protection.



Determining the adequacy of HPD attenuation continued)...

Target:
Your goal is to reduce the effective exposure of a worker to a value equal to or less than the OSHA standard of...
90dBA



***Piece of cake!!
Let's walk through it.***

STEP ONE: Determine how many decibels you are over the limit in your workplace.

Example: Your Workplace Value = 105dB,
so for this example..... 105dB minus 90dB = 15 dB

STEP TWO: Determine whether your workplace decibel measurements are made using the A scale (dBA) or the C scale (dBC) = A (or C) scale

Some thoughts on selection of "correct" HPD

- A wide variety of plugs, caps and muffs are available to choose from.
- All come with an **NRR** rating, what the manufacturer says is this product's **"Noise Reduction Rating"**. **Don't you believe it!**
- In general, you want to select an option with a higher NRR rating but more importantly, one which the employee will **use**. If a selected HPD is uncomfortable or difficult to use, an employee will be less likely to use it.

Determining the adequacy of HPD attenuation continued)...



***Piece of cake!!
Honest! Stay
with me here...***

STEP THREE: Let's calculate how high an NRR rating we will need.

For our example: Let's select an HPD that has an **NRR rating of 21 dB**.

Choose one of the two options below:

Option A: Use this option if the scale used in Step Two is in dBA :

- Subtract 7 from the selected HPD's NRR rating:
 $= [21 \text{ minus } 7 = 14]$
- Divide that number by 2: = $[14 / 2 = 7]$
- Subtract this value from the number of decibels you are over limit (calculated on the previous page (= **15dB in our example**):

15dB - 7 = 8dB.....this still exceeds the OSHA Standard.

Obviously we will have to select an HPD with a higher NRR rating and recalculate, using this same procedure until we drop below the maximum allowable exposure.



Option B: Use this option if the scale used in Step Two was DbC.

- If YourWorkplaceValue is measured in units of dB \underline{C} , follow the same steps outlined in Option A, except do not subtract the 7 in step one.

Determining the adequacy of HPD attenuation concluded)...



Told you so!

Now, one more thing and we're done...

Well then, What about using plugs and muffs together?

Simple!

- **Add 5dB** to the value of the higher-rated HPD, but only after following the steps on the previous page.
- Example: Let's say $NRR_{\text{plug}} = 30$ and $NRR_{\text{muff}} = 21$.

$$[(30 - 7)/2] + 5\text{dB} = 17 \text{ dB of effective protection}$$

Eureka! By combining two forms of HPD's, we now fall within the parameters of the OSHA standard.

4. Education and training

1. A training program is mandatory for all employees exposed at or above the action level of _____ .
2. Training must be repeated at least _____ each year and must be updated to be consistent with changes in protective equipment and work processes.

Topics required to be a part of the training program

- a) *Effects of noise on hearing .*
- b) *Purpose of hearing protectors .*
- c) *Advantages/disadvantages and attenuation of various types .*
- d) *Instructions on selection, fitting, use and care .*
- e) *Purpose of audiometric testing and an explanation of test procedures .*

5. Recordkeeping

All audiometric test records obtained during the course of an employee's employment must also be retained. The employer must maintain accurate records of all employee noise exposure measurements for...

_____years.

OSHA 300 Log Recordkeeping Issues

OSHA Issues Final Rule for Recording Occupational Hearing Loss

For those professionals working in occupational health and safety settings, one of the most complicated responsibilities has traditionally been the reporting of work-related injuries and illnesses as required by OSHA.

On July 1, 2002, OSHA published its final rule for recording occupational hearing loss on the Form 300 Log of Work-Related Injuries and Illnesses (OAR 437-001-0700); effective date January 1, 2003. Additional clarifications were released on December 17, 2002.

Forms: OSHA has also updated its recordkeeping forms (now OSHA Form 300, 301 and 300A). **Beginning January 1, 2004**, employers will be required to record hearing loss cases in a separate column. In 2003, employers should record cases of occupational hearing loss as an "injury" (single event acoustic trauma) or "other illness" (long term noise exposure), as appropriate. Although state-run OSHA plans were allowed to continue utilizing more stringent enforcement criteria during 2002, all are required to adopt the final federal rule for hearing loss recordability, effective January 1, 2003.

Applicable industries: Under Oregon OSHA rules, all industries are included.

OSHA 300 Log Recordkeeping Issues

Summary of the Final Rule *continued...*

- **Basic recording criterion:** Employers must record work-related "Standard Threshold Shift", or STS (an average change of 10 dB at 2000, 3000, and 4000 Hz in either ear, compared to baseline; age-adjustments allowed) **provided that** the employee's average hearing level at the same frequencies in the same ear is 25 dB hearing loss (HL) or greater (an average hearing level of 25 dB or more, regardless of employee's age, i.e., no age adjustment allowed).
- **Baseline/reference audiogram:** To determine whether a STS has occurred, the employer must compare the current hearing test results to the employee's baseline audiogram. The baseline audiogram is the employee's original audiogram or revised audiogram as defined under OSHA's noise standard OAR 437-002-1910.95.
- **Reconfirmation of STS:** If the annual audiogram shows a STS, a hearing retest may be performed within 30 days. If the retest does not confirm the STS, then the case need not be recorded. However, if the retest confirms the STS, then the STS if work-related, must be recorded within 7 calendar days of retest. If a retest is not performed, then the case (again, if work-related) must be recorded within 37 days of test.

OSHA 300 Log Recordkeeping Issues

Summary of the Final Rule **(concluded)...**

- **Results of subsequent testing:** If later testing performed as part of the hearing conservation program indicates that the STS is not persistent, then the employer may erase or line-out the recorded entry.
- **Determination of work-relatedness:** Work-relatedness must be determined according to specifications of 437-001-0700(6) of Oregon's general recordkeeping rule. If an event/exposure in the workplace caused or contributed to the shift in hearing or "significantly aggravated" a previously existing hearing loss, then the STS is recordable.

FAQ: Recording criteria for cases involving occupational hearing loss

Basic requirement:

If an employee's hearing test (audiogram) reveals that the employee has experienced a work-related Standard Threshold Shift (STS) in hearing in one or both ears, and the employee's total hearing level is 25 decibels(dB) or more above audiometric zero (averaged at 2000, 3000, and 4000 Hz) in the same ear(s) as the STS, you must record the case on the OSHA 300 Log.

What is a Standard Threshold Shift?

A Standard Threshold Shift, or STS, is defined as a change in hearing threshold, relative to the baseline audiogram for that employee, of an average of 10 decibels (dB) or more at 2000, 3000, and 4000 hertz (Hz) in one or both ears.

How do I evaluate the current audiogram to determine whether an employee has an STS and a 25-dB hearing level?

STS

If the employee has never previously experienced a recordable hearing loss, you must compare the employee's current audiogram with that employee's baseline audiogram. If the employee has previously experienced a recordable hearing loss, you must compare the employee's current audiogram with the employee's revised baseline audiogram (the audiogram reflecting the employee's previous recordable hearing loss case).

25-dB loss

Audiometric test results reflect the employee's overall hearing ability in comparison to audiometric zero. Therefore, using the employee's current audiogram, you must use the average hearing level at 2000, 3000, and 4000 Hz to determine whether or not the employee's total hearing level is 25 dB or more.

FAQ: Recording criteria for cases involving occupational hearing loss (continued)...

May I adjust the current audiogram to reflect the effects of aging on hearing?

No and Yes.

No, you cannot use age correction for determining whether an employee has reached the 25dB threshold above audiometric zero. You cannot age-correct an audiogram for determining a Standard Threshold Shift (STS) for purposes of OAR 437-002-1910.95, "Occupational Noise Exposure".

And Yes, **for recordkeeping purposes**. When determining whether you must record an STS on the OSHA 300 Log, you can allow for the contribution of aging by adjusting the current audiogram (see Appendix A to 437-001-0700, Age-Related Hearing Loss).

Do I have to record the hearing loss if I am going to retest the employee's hearing?

No, if you retest the employee's hearing within 30 days of the first test, and the retest does not confirm the recordable STS, you are not required to record the hearing loss case on the OSHA 300 Log. If the retest confirms the recordable STS, you must record the hearing loss illness within seven (7) calendar days of the retest. If subsequent audiometric testing performed under the testing requirements of the noise standard (OAR 437-002-1910.95) indicates that an STS is not persistent, you may erase or line-out the recorded entry.

Are there any special rules for determining whether a hearing loss case is work-related?

No. If an event or exposure in the work environment either caused or contributed to the hearing loss, or significantly aggravated a pre-existing hearing loss, you must consider the case to be work related.

FAQ: Recording criteria for cases involving occupational hearing loss (concluded)...

If a physician or other licensed health care professional determines the hearing loss is not work-related, do I still need to record the case?

If a physician or other licensed health care professional determines that the hearing loss is not work-related or has not been significantly aggravated by occupational noise exposure, you are not required to consider the case work-related or to record the case on the OSHA 300 Log.

How do I complete the 300 Log for a hearing loss case?

When you enter a recordable hearing loss case on the OSHA 300 Log, you must check the 300 Log column for hearing loss. (**Note: effective beginning January 1, 2004.**)

300 Log Recordkeeping Format

An Overview: Recording Work-Related Injuries and Illnesses

The Occupational Safety and Health (OSHA) Act of 1970 requires certain employers to prepare and maintain records of work-related injuries and illnesses. Use these definitions when you classify cases on the Log. OSHA's recordkeeping regulation (see 29 CFR Part 1904) provides more information about the definitions below.

The Log of Work-Related Injuries and Illnesses (Form 300) is used to classify work-related injuries and illnesses and to note the extent and severity of each case. When an incident occurs, use the Log to record specific details about what happened and how it happened. The Summary—a separate form (Form 300A)—shows the totals for the year in each category. At the end of the year, post the Summary in a visible location so that your employees are aware of the injuries and illnesses occurring in their workplace.

Employers must keep a Log for each establishment or site. If you have more than one establishment, you must keep a separate Log and Summary for each physical location that is expected to be in operation for one year or longer.

Note that your employees have the right to review your injury and illness records. For more information, see 29 Code of Federal Regulations Part 1904.35, *Employee Involvement*.

Cases based on the Log of Work-Related Injuries and Illnesses are not necessarily eligible for workers' compensation or other insurance benefits. Listing a case on the Log does not mean that the employer or worker was at fault or that an OSHA standard was violated.

When is an injury or illness considered

presumed for injuries and illnesses resulting from events or exposures occurring in the workplace, unless an exception specifically applies. See 29 CFR Part 1904.2(b)(2) for the exceptions. The work environment includes the establishment and other locations where one or more employees are working or are present as a condition of their employment. See 29 CFR Part 1904.5(b)(1).

Which work-related injuries and illnesses should you record?

Record those work-related injuries and illnesses that result in:

- ▼ death,
- ▼ loss of consciousness,
- ▼ days away from work,
- ▼ restricted work activity or job transfer, or
- ▼ medical treatment beyond first aid.

You must also record work-related injuries and illnesses that are significant (as defined below) or meet any of the additional criteria listed below.

You must record any significant work-related injury or illness that is diagnosed by a physician or other licensed health care professional. You must record any work-related case involving cancer, chronic irreversible

What are the additional criteria?

You must record the following conditions when they are work-related:

- ▼ any needlestick injury or cut from a sharp object that is contaminated with another person's blood or other potentially infectious material;
- ▼ any case requiring an employee to be medically removed under the requirements of an OSHA health standard;
- ▼ tuberculosis infection as evidenced by a positive skin test or diagnosis by a physician or other licensed health care professional after exposure to a known case of active tuberculosis;
- ▼ an employee's hearing test (audiogram) reveals (1) that the employee has experienced a Standard Threshold Shift (STS) in hearing in one or both ears (averaged at 2000, 3000, and 4000 Hz) and (2) the employee's total hearing level is 25 decibels (dB) or more above audiometric zero (also averaged at 2000, 3000, and 4000 Hz) in the same ear(s).

What is medical treatment?

Medical treatment includes any medical care beyond first aid for a patient for a condition that is not a minor injury or illness.

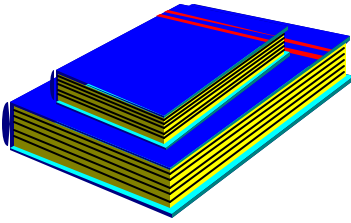
▼ an employee's hearing test (audiogram) reveals 1) that the employee has experienced a Standard Threshold Shift (STS) in hearing in one or both ears (averaged at 2000, 3000, and 4000 Hz) and 2) the employee's total hearing level is 25 decibels (dB) or more above audiometric zero (also averaged at 2000, 3000, and 4000 Hz) in the same ear(s) as the STS.

Hearing Loss

Noise-induced hearing loss is defined for recordkeeping purposes as a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more in either ear at 2000, 3000 and 4000 hertz, and the employee's total hearing level is 25 decibels (dB) or more above audiometric zero (also averaged at 2000, 3000, and 4000 hertz) in the same ear(s).

Enter the number of days the injured or ill worker was:		Check the "Injury" column or choose one type of illness:					
Away from work	On job transfer or restriction	(M)					
(K)	(L)	Injury	Skin disorders	Respiratory conditions	Poisoning	Hearing loss	All other illnesses
(1)	(2)	(3)	(4)	(5)	(6)		
12 days	15 days	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____ days	30 days	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7 days	30 days	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 days	_____ days	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
_____ days	_____ days	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Department of Labor
Safety and Health Administration



Appendices

- A. How Decibels Work
- B. Buying Quiet - 1
- C. Buying Quiet - 2
- D. Building Quiet
- E. Working Quiet - 1
- F. Working Quiet - 2
- G. OR-OSHA Occupational Noise Exposure Code
OAR 437, Division 2 (29CFR 1910)

Appendix A

How Decibels work

IMAGINE, by imperial decree, that everyone on planet Earth is now required to express length in units of inches only. All other units of length have been abolished. No big deal in everyday applications; even the diameter of something as small as the period at the end of this sentence could be expressed easily as 0.01 inches. But what about the length of the playing surface of a football field (3,600 inches), a 20-mile trip to Grandma's house (1,267,000 inches), or a trip around the world (1,584,000,000 inches)? Pretty cumbersome, right? And we've not even started the computations for our Earth-to-Mars round trip yet!

One of the primary purposes of the decibel scale is to make the usable range of sound pressures more manageable. The pressure variations in a sound wave are measured in terms of a unit borrowed from meteorology called the ***microbar***. A microbar is one-millionth of the normal atmospheric pressure.

The range of sound pressures to which the human ear may be exposed is enormous. For example, the weakest sound that can be heard by a person with very good hearing is about 0.0002 microbars at 1,000 cycles per second, while the noise near a jet engine may be **ten million times this level**, or 2,000 microbars.

To make their work easier, scientists frequently create different scales of measure. Let's use our "inches-only" example to illustrate. If we were, in fact, confined to using inches as our sole unit of length, we could try to make the numbers more manageable by using logarithms. Logarithms essentially compress or squeeze a wide range of numbers into a smaller scale. Every tenfold change in our physical units results in an increase or decrease on the log scale of just one unit.

Appendix A

How Decibels work (continued)...

Let's see what happens when we compress our length scale by applying the logarithm to the set of lengths in the example above. We'll arbitrarily refer to this new scale of length based on the logarithm of length in inches as the '**login scale**'...

- The 'period' with a diameter of .01 inches now equals: **-2.0 logins**
(\log_{10} of 0.01);
- The football field now equals: **+ 3.5 logins**; and...
- The trip around the world now equals: **+ 9.2 logins** .

Wow! The logarithm function has really squeezed things together. The period at the end of this sentence has a diameter of -2.0 logins, and a trip around the world is just 11.2 logins greater, at $+9.2$ logins. Now, if we were fairly certain that the diameter of this period was close to the smallest object we'd ever be interested in measuring, we could eliminate all negative numbers by taking the logarithm of ratios in which the denominator of the ratio is always 0.01 inches. This is just a way to make the zero point of the scale correspond to the smallest measurement that is likely to be made. In this new login scale, all values calculated previously simply increase by 2.0 . Thus, our login values for this example range from **0.0** logins (the 'period', at \log_{10} of $0.01/0.01$) to the trip around the world at **11.2** logins.

Perhaps we've gotten a little carried away and compressed our system of length measurement too much. We could **uncompress** it by multiplying the logins by some factor of our choosing, say, by 10 (call these decilogins), or 100 (centilogins) or 1000 (millilogins). Let's select a factor of 10 , so that now, in decilogins, our range of lengths would span from 0.0 decilogins to 112 decilogins for our trip around the world. Cool, huh?

Appendix A

How Decibels work (concluded)...

So, what does this have to do with noise and decibels and stuff?

Remember on page 10, we learned that the range of sound pressures to which the ears are exposed is in the millions?

In order to express this wide range of pressure in small, convenient numbers, a unit called the **bel** was created, so named in honor of Alexander Graham Bell. The bel can be defined as the logarithm of the ratio of two sound pressures. However, it reduced the numbers too much, so that the **decibel (ten times the bel)**, came into common use.

In acoustics, the decibel is most often used for expressing the sound-pressure level with respect to a reference sound pressure. For airborne sound, this reference sound pressure is generally **0.0002 microbar, which is also called zero decibels** or, the starting point on the scale of noise levels.

So now you know more than most of the kids on the block about decibels. We simply use logarithms to compress an unmanageable range of sound pressures into a more reasonable scale of numbers that is then expanded slightly through multiplication by a factor of 10.

Just one more point and we're done...The logarithm function was not chosen arbitrarily to perform this compression of the sound pressure scale. It was chosen both for its mathematical compression capabilities and because a similar type of compression is believed to be performed by the auditory system when presented with sounds covering a wide range of sound pressures.

**Got it? Good! You pass! Now for extra credit, here's a...
Pop Quiz....**

The correct spelling of our word for the day is: (a) Decibel (b) decibel... or
(c) deciBel (C is correct)

A measurement of zero decibels means an absence of sound.
True or... False! Zero deciBels simply means the sound
(pressure) is equal to the reference level.

BUYING QUIET - 1

Noise at Work

One of the most cost-effective ways of reducing noise in the workplace is "buying quiet". This pamphlet gives some ideas on how to purchase a quieter product.

Is There a Quieter Process?

Before you buy plant or equipment, ask yourself if there is a quieter way of doing the job. For example, before buying a pneumatic impact wrench, consider the various hydraulic and torque-controlled units now available. While these units may cost more, they last longer and cause less damage to the nut, as well as lowering noise and hand-arm vibration levels.

Getting the Information

If you think the machine you are buying may be noisy, ask for noise level information from the supplier. Some suppliers may be reluctant to give out this information, so you may need to keep asking. The information is almost always available to the supplier from the manufacturer. Under the Occupational Safety and Health Act, the supplier is obliged to provide adequate information at the time of supply, so the law is on your side.

Making Sense of It

To make sense of noise level information from a supplier, you will need to ask several questions:

1. Is this information complete?

Insist on the full data from the supplier.

2. Can I compare brands?

If two similar items of plant have been tested according to the same Test Standard, then you can probably do a straight comparison of the sound levels to see which brand is quieter. If the items have been tested to different Standards, or no Standards at all, comparisons may be hard. You would need to compare such things as the way the machine was mounted and operated, how far away the measurements were done and so on.

The European Community is busy preparing hundreds of Test Codes for all types of machinery, so that comparable test results can be published. Over the next few years, manufacturers will begin to give out this type of useful information - keep asking for it.

3. Is there a quieter version of the same machine?

Sometimes the manufacturer will have a specially silenced model - or an add-on silencer - for a machine which may be suitable for your task. For example, you may buy a brick saw with or without a vibration damped blade ([see pamphlet on Selecting a Sawblade](#)). But don't be put off by higher costs. Look at the extra cost of the "add-on" and divide it by the number of decibels reduction achieved - you'll find that these add-ons usually amount to very cheap and effective noise control.

Appendix B

4. What will this noise level mean in my workplace?

You may be able to get a rough idea of the noise level of the item in your workplace, from the manufacturer's noise information. Ideally, the manufacturer will have tested the machine for noise level at the operator's ear position, while carrying out a typical task. In this case, the noise level in your workplace should be very similar.

Some manufacturers quote noise levels with their machines "free running", and these levels may change when the machine is actually working. For example, angle grinders are usually much noisier when working than when free running. From experience, you will know which machines



are likely to be a lot noisier when working, and in these cases it may be too hard to estimate noise levels in the workplace. (Free running noise level is still important, however, in these cases, as most machines spend a significant amount of time in free running mode).

You need to be aware that noise levels quoted on labels are measured at specified distances, e.g. 1 metre, and may not be the same as the level at your ear. As a rough guide, add 6 decibels (dB) to the noise level for each halving of the distance - the noise level at 0.5 metre will be about 6dB higher than at 1 metre, (in the case of a hand-held machine). A few machines (eg lawnmowers), state noise levels taken at 7 metres for neighbourhood noise, but the noise level is much higher for the operator.

Making Your Decision

Most people would choose the quieter machine, but the reality is, quieter machines usually cost a bit more. Manufacturing tolerances are tighter, gears are made to mesh better, quieter cooling fans are used, and so on. The question is: does the decibel reduction justify the extra cost? If a machine that is 5 decibels quieter costs \$100 more, than the extra cost of \$20 per dB can be considered cheap noise control. There are also the hidden benefits of a quieter machine - it is easier to hear warning sounds, it is less stressful and tiring to use, and you can be less reliant on personal hearing protectors.

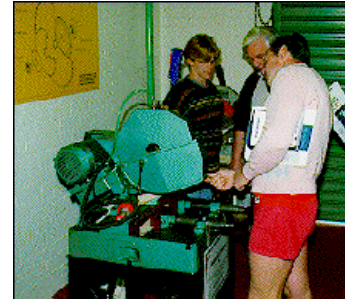
If tradespersons and their employers don't demand quieter machines, there will be little incentive for manufacturers to produce them and in the end the users will be the losers.

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BUYING QUIET - 2

SELECTING A SAWBLADE

In all types of sawing work, noise has to be taken into account, along with other safety points. When you select a sawblade, you choose how much noise you, and others, will be exposed to - noise that could damage your hearing and make the job unpleasant. The ideas in this pamphlet will help you to select the best sawblade for low noise, and should apply to all types of sawing work.



How They Make Noise

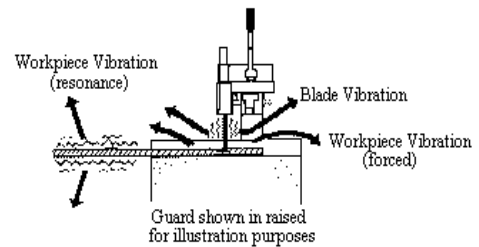
Sawblades do their work through the impact of each tooth on the workpiece. Some saw teeth break off small pieces of the material, as when cutting aluminium; others, like timber rip saws, slice their way through the material.

The force which each saw tooth applies to the material causes fracture of the material, but also causes shock waves to travel through the material and through the blade. These waves, or vibrations, radiate as noise.

Noise: Wasted Energy

Some people think a noisy machine must be doing a good job, but in a way it's just wasting energy. The ideal sawblade is one which directs maximum energy into cutting, and very little into vibration and noise. So a quiet blade should also be efficient in cutting. The noise made by a sawblade when cutting depends on a number of factors, including:

- number of teeth - more teeth usually causes less noise, as there is less impact force per tooth;
- size of teeth - smaller teeth also cause less noise, for the same reason; and
- shape of teeth - generally, the sawblade manufacturers have adopted what they think are best all-round tooth profiles for efficient cutting.



**Selection
Rule No.1**

Choose a sawblade with the greatest number of teeth, of the smallest width, suitable for the job.

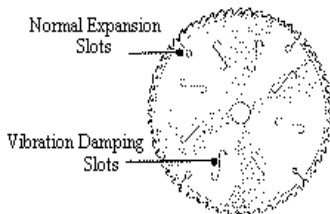
Appendix C

Blade Vibration Control

In many cutting processes, vibration of the sawblade is a major noise source - even when you have followed Rule 1 and selected a blade with the largest numbers of small teeth. If you strike a sawblade, it will "ring" like a bell, because of its elastic properties. In the same way, each tooth striking the workpiece will cause the sawblade to "Ring". The amount of ringing depends on the vibration "damping" of the sawblade. If you put your hand on a ringing bell, the sound stops, because you have "damped" the vibration.

Some good sawblades have vibration "damping" built in. This may be in the form of slots cut into the body of the sawblade (to stop vibration energy running around the blade).

Sawblade with Built-in Vibration Damping



Note that the normal expansion slots which are cut into tungsten carbide tipped blades do not go deep enough to eliminate vibration.

Another form of vibration damping is an internal damping layer built into the blade.

You can tell whether a blade has any built-in vibration damping by tapping it - a well damped blade will respond with a dull "tick", rather than a "ting".

Selection Rule No.2

Choose a sawblade with built-in vibration damping.

Air Noise

When free running or idling, a sawblade can still make a lot of noise. This aerodynamic noise is caused by pockets of air being trapped in the saw gullets (the gaps between the teeth). As these pockets of air speed past the still air - often at speeds of over 200 km/h - the shearing effect of air against air creates noise. The larger the gullet size, the more noise is created.

Selection Rule No.3

Choose a sawblade with gullets as small as possible, while still allowing for removal of material.

Using the Sawblade

Here are some good general pointers for keeping your sawblade noise at the lowest level:

- sharpen the blade regularly - blunt or chipped teeth reduce cutting efficiency and increase noise;
- ensure side to side runout ("wobbling") is small, when attaching the blade;
- keep the saw machine itself in good order through regular maintenance of bearings, belts etc; and
- select a running speed that gives least noise (a high speed causes more air noise but often gives less cutting noise).

Appendix C

What the Tests Show

Sound level tests* on different sawblades under comparable conditions, show that these three Selection Rules really do make a difference. Here are some examples:

	Sound Level - dB(A) at Operator Position (10-second average)
Tooth number and size	
Cutting lengths of aluminium	
- 350mm dia. TCT blade, 84 teeth, 3.5mm wide	97
- 350mm dia, TCT blade, 108 teeth, 3.2 mm wide	91
Reduction, dB(A)	6
Vibration Damping	
Cutting bricks	
- 350mm dia. "standard" masonry blade, 20 teeth	94
- 350 mm dia. "damped" masonry blade, 20 teeth	84
Reduction, dB(A)	10
Air Noise	
"Dummy cut" (run up to 3400 rpm, run down), without cutting	
- 350mm dia. TCT blade, 84 gullets, 10mm x 7 mm	91
- 350 mm dia. TCT blade, 108 gullets, 8mm x 4mm	84
Reduction, dB(A)	7

* WorkSafe Western Australia

Engineering Noise Control Reports No's. ENC-2-93, ENC-4-93.

These noise reduction results are significant. A 10 decibel reduction means the amount of sound energy has been reduced to a tenth (10%) of its original value, and to the ear, sounds about "half as loud".

Remember

There are three rules for selecting a sawblade

1. Choose a sawblade with the greatest number of teeth, of the smallest width, suitable for the job.
2. Choose a sawblade with vibration damping built in.
3. Choose a sawblade with gullets as small as possible, while still allowing for removal of material.

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BUILDING QUIET

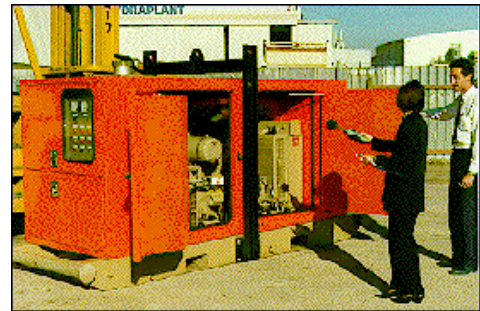
ACOUSTIC ENCLOSURES, BARRIERS AND ISOLATION

There may be times when you will need to use your skills to construct an acoustic enclosure or screen, soundproof a room or fabricate acoustic ductwork. This brochure gives some tips on materials to use and how to avoid the common pitfalls.

What Acoustic Materials Do

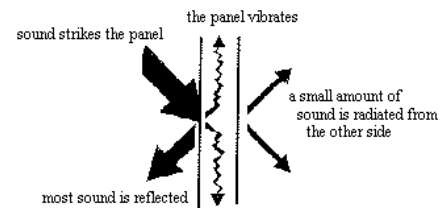
The materials you use for noise reduction can work in four basic ways

SOUND ISOLATION - STOPPING SOUND FROM PASSING THROUGH, BY REFLECTING IT.



SOUND ISOLATION

Stiff heavy materials will stop a lot of sound, although limp, heavy materials are also good. Common materials include sheet metal, timber, masonry, plasterboard, glass and loaded vinyl. These can also be used in double leaf constructions, e.g., plasterboard on timber studs, doubled glazed windows, in which case the air space needs to be as wide as possible.

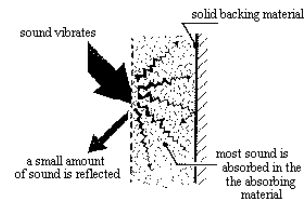


Porous materials, perforated materials or very light materials are poor performers for noise isolation, although they may be good sound absorbers.

SOUND ABSORPTION - SOAKING UP SOUND SO IT IS NOT REFLECTED.

SOUND ABSORPTION

Porous materials such as open cell foams and fibrous materials (fibreglass, rockwool) act as very good sound absorbers by converting sound energy to a small amount of heat. Note however that most sound absorbing materials are poor performers for noise isolation, as they allow sound to pass through easily. This is why sound absorbing material is usually fixed onto a solid noise isolating material.



Closed-cell foams, eg polystyrene, are poor sound absorbers.

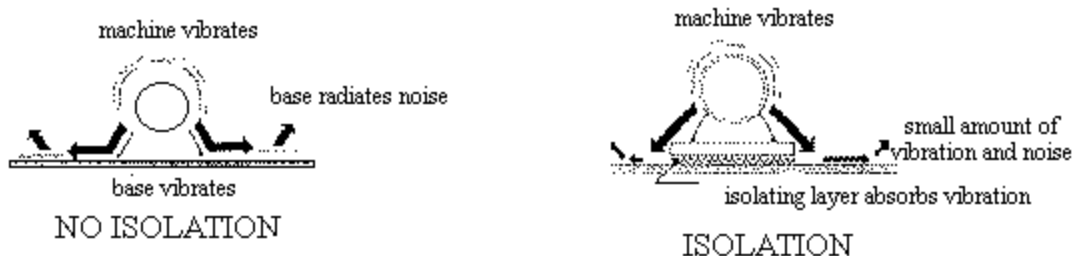
Sound absorbing materials often need to have a protective facing to prevent damage. Common facings include perforated sheet metal (10% open area), perforated foil (sisalation), or perforated vinyl.

Appendix D

When it is necessary to prevent moisture entering or fibres leaving, e.g., in the food industry, a thin layer (typically 25 microns) of a tough material such as polyethylene is often used as a facing.

VIBRATION ISOLATION - STOPPING VIBRATION ENERGY PASSING FROM ONE POINT TO ANOTHER.

VIBRATION ISOLATION



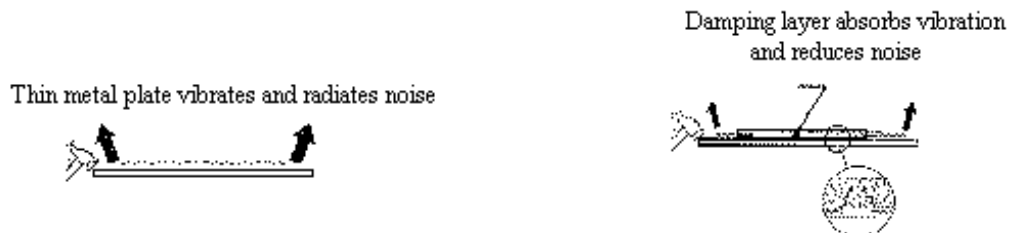
Materials which are "springy" can be used to isolate a vibrating machine from a floor, wall, or ceiling. These can take the form of springs, rubber mounts, air cushions, pads or mats of rubber, cork or fibreglass. Selection of the best isolator for a job is a specialised task.

Springy materials are also very good as buffers for absorbing impacts.

Example: Put the tip of your finger on a wine glass and tap the glass. It should ring. Now tap your finger. What happens? Why?

VIBRATION ABSORPTION - SOAKING UP THE VIBRATION BY DAMPING.

VIBRATION ABSORPTION



Materials which have good internal "damping" can be used to absorb vibration energy. A material which will not "ring" when tapped has good internal damping, and can be used to absorb the ringing of lightly damped materials.

Appendix D

Example: Why does a wine glass which has been tapped stop ringing when you place your hand on it? Answer: Your hand is made of highly damped material!

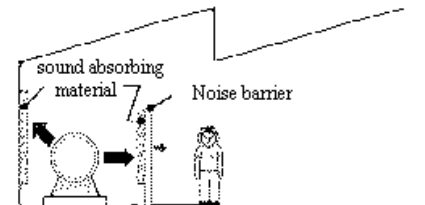
Damping materials include foams, rubbers, soft wood and granular materials such as sand.

ACOUSTIC BARRIERS AND SCREENS

You can screen noise by building a noise barrier.

NOISE BARRIER

The sound absorbing layer stops sound echoing in the area near the source and bouncing over the barrier. It can be secured at its edges in metal channel sections or with timber studs and given a protective facing (see "sound absorption" above).



Some ideas:

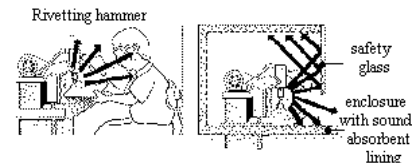
- make it a mobile screen by adding wheels;
- add a glass or perspex viewing window; and
- sound absorbing material on the ceiling above and the wall behind - it will work better.

Acoustic Enclosures

An acoustic enclosure can range in size from a small box or cover to a tractor cab, up to a large machine enclosure or sound proofed room.

Points to watch

- The wall materials need to be heavy enough to isolate the required amount of sound (see "sound isolation" above).
- Use an absorbing layer on the inside to reduce sound build-up.
- Seal off any gaps or openings by block-off pieces and gunned sealant, or flexible flaps where openings are necessary.
- Make sure any doors, hatches or removable panels have full seals on each contacting edge.
- Make sure the enclosure is not touching any vibrating part of the machine, or it may vibrate as well - isolate any pipework which penetrates the enclosure, sealing the gap with soft sealant.
- Don't forget that the machine may need ventilation - provide silenced airflow ductwork (see next page).



Appendix D

Acoustic Ductwork

Acoustic ducts can allow enough airflow while absorbing noise as it passes along the duct. Note also that noise travels along intake ducts against the airflow.

Points to watch.

- The outer ductwork layer needs to be thick enough to prevent noise "breakout".
- The absorbing material needs to be thick enough to absorb sound over a wide range of frequencies, e.g., 50mm thick fibreglass is a typical lining thickness.
- The duct cross-section needs to be large enough to allow air to flow with little restriction.
- The length of duct which is lined with absorbing material needs to be long enough to reduce sound sufficiently - the larger the duct size, the longer the lined length needs to be.
- You may need to insert a flexible "vibration break" between the lined duct and the noise source (see next page).

Vibration Isolation

Situations where you may see a need for vibration isolation include:

- a vibrating machine rigidly mounted on a floor above ground;
- pipework (from a vibrating machine) rigidly fixed to a wall or ceiling; and
- part of a machine touching or connected to a large panel which can vibrate (and radiate noise), e.g., a ceiling-mounted air conditioner touching the ceiling grid.

While selecting the right vibration isolators is often a specialist task, you could be called on to install the isolators.

Points to note:

- make sure you don't "bottom" the isolator by over-tightening or squashing it flat - it should be free to move a little;
- make sure the sideways movement of the isolated machine, when running up or down, is not excessive (some isolators will "resonate" at lower speeds, requiring additional vibration dampers); and
- watch out for other rigid connections between the isolated machine and other surfaces, e.g., a rigid electrical conduit which can convey vibration around the isolator, effectively "short-circuiting" it.

In summary

Your skills can be used to reduce noise in the workplace. Having a basic knowledge of acoustic materials and how they work, and knowing some of the pitfalls in "building quiet" will help. For further assistance, you can contact the material suppliers or look up any good text on architectural acoustics.

WORKING QUIET - 1

MAKING THE JOB QUIETER

A lot of the noise which you are exposed to in your trade can be reduced by "working quiet". Just what is "working quiet"? It really means looking at the task you are about to do, thinking about the noise you will make, and asking these basic questions.

1. Is there a quieter method of doing this job?
2. Is there a way of damping down the amount of noise I have to make? Can I separate my noise so other people aren't exposed to it?

This pamphlet gives some guiding principles and practical ideas for working quiet.

USE QUIETER METHODS

Impact or Pressure

Using impacts (Short, sharp bursts of energy, e.g., a hammer) to do a job can be very effective, but noisy. Sharp impacts cause high peak noise levels, which can sometimes cause instant permanent hearing loss. Sometimes, using a steady pressure can bring the same result, with a lot less noise.

- Bend metal in a press or a vice instead of hammering; and
- Screw type fittings are usually quieter to insert than nails.

Choose quieter tools or machines

Ideally, your workplace should have noise level information (either from the manufacturers or from measurements done in the workplace) for each noisy piece of plant. Using this, you can select the quietest plant for the job.

- An electric power tool may be quieter than a pneumatic one; and
- choose a silenced compressor or power pack.



Reduce noisy work

The risk of noise deafness depends on both the noise level and the time you are exposed, so choose methods which reduce the amount of time spent on noisy work.

- More accurate cutting, bending, welding and fixing means less need for noisy corrective work in hammering and grinding; and
- if two machines produce roughly the same noise, use the faster one.

Appendix E

REDUCE NOISE OUTPUT

Reduce Impact Velocity

Impact noise can be reduced by lowering the velocity of impact.

- Lower materials slowly to the ground or floor, using the proper manual handling techniques; and
- reduce the fall height of objects such as tools, offcuts etc. by using a bench, breaking the fall of the object or working close to the ground.

Spread impacts over a longer time

By spreading the impact over a slightly longer time, it is possible to do the same work with less noise.

- Use a "dead blow" hammer (filled with lead shot) or a soft face hammer; and
- place a wood block between the hammer and workpiece.

Cushion impacts

Many impact noises need never occur!

- Use rubber floor mats to cushion noise of falling or rolling objects;
- treat work benches;



- line scrap bins with rubber; and
- use rubber buffers on truck trays, bin lids, gates etc..

Reduce working forces

Sometimes the system provides more "grunt" than you need.

- Reduce compressed air line pressure (using a regulator) to the minimum needed for the task, when using nail guns, air hammers, etc; and
- avoid overloading machinery so that it "screams".

Damp the noise radiation

The "ringing" resonance of materials which have been impacted can be reduced by damping the vibration, in the same way as you can damp the ringing of a wine glass by putting your hand on it. The brochure on [Building Quiet](#) gives information on damping.

- Lay rubber blankets or sand-filled bags on the vibrating workpiece; and
- use materials which radiate less noise than sheet metal, e.g., steel mesh, plastic for scrap bins, guards etc.

Appendix E

SEPARATE THE NOISE FROM THE PEOPLE

Increase "distance"

Even if you have to be exposed to your own noise, others in a workplace can avoid unnecessary noise if you are careful where you position your plant.

- Try not to work in a corner, or an "echo-ey" area, as this increases noise;
- work further away from others, even outside;
- use mobile screens or work behind partitions; and
- locate your compressor or power pack further away, outside or behind a screen.

Control access to noise areas

There are some simple ways of preventing people being in areas where noise is occurring.

- Restrict access to noisy areas by cordoning off and/or warning signs, in consultation with the relevant persons on site; and
- arrange to carry out very noisy tasks at times when other employees are not at the workplace.

Summary

The ideal is to eliminate or reduce noise at the source, by using a quieter method for doing the task, or using a quieter machine. So the ideas at the top of the list in this brochure should take priority over the lower ones.

Instead of you having to think of these points every time you do a job, work through the most useful ideas in consultation with others in your workplace to come up with a set of procedures for Working Quiet.

Copies of this publication may be freely printed and distributed provided that WorkSafe Western Australia receives appropriate acknowledgement, and that no substantial changes are made to the text.

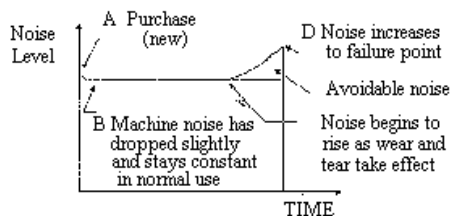
WORKING QUIET - 2

MAINTAINING YOUR MACHINES

Maintaining your plant and equipment in good order not only increases its life, but makes it safer to use and also quieter.

How wear and tear affects noise output

We can understand this by looking at the "bathtub" curve. This shows what happens to the noise output of a machine over its working life.



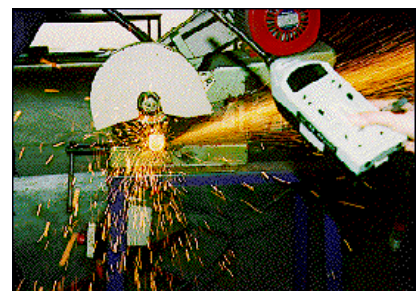
Servicing needs to be carried out at Point C, before the wear and tear becomes serious. By doing this, we may not achieve a large noise reduction, as the noise level will drop back to the level at Point A or Point B. But what we will do is to avoid the period of high noise exposure up to Point D (shaded area of graph).

Not only this, but repairs carried out at Point D are going to be much more expensive.

What WorkSafe Western Australia found

WorkSafe Western Australia carried out a study to see how this works in practice. (Report ENC-6-94).

- A total of 11 power tools, including drills, angle grinders, sanders, a circular saw and a planer were tested for noise "before" and "after" routine servicing at a commercial power tool service center.
- The average noise level 0.5 m away was 93.9 dB(A) "before" and 92.0 dB(A) "after".
- Noise reductions ranged up to 7 dB(A).
- The average reduction was 1.6 dB(A).
- As expected, this average reduction is small in terms of decibels. However, it means that sound energy output before maintenance was 45% higher, showing that wear and tear was clearly on the rise. This shows that noise levels had increased from Point B to beyond Point C on the curve.



Appendix F

- One machine with badly chipped gear teeth had reached Point D on the curve. Its noise output had risen to 100 dB(A), mostly because of a dramatic rise in gear noise level (it was not included in the 11 machines tested as it was not able to be repaired and re-measured at the time.)
- The average cost of repairs related to noise reduction was about \$50, or about \$30 per decibel of noise eliminated. This is cheap noise control, especially when you think of the expensive repairs and the noise you have avoided!

In other studies on specific machines, the Department achieved significant noise reductions through careful maintenance work:

- The noise level of a common type of reciprocating compressor was reduced by about 8 dB(A), by adjusting the valve seating to improve the seal and adding "Molyslip" additive to the lubricating oil to reduce roughness in the piston stroke, (Report ENC-7-94).
- The noise level of a pneumatic knife used in abattoirs was reduced by about 8 dB(A), by improving the balance of the rotor vanes and replacing bearings and a worn collar which allowed parts to rattle (Report ENC-3-93).
- The noise level of an electric motor and belt drive for an aluminium docking saw was reduced by 15 dB(A) when free running, by replacing squealing belts and worn motor bearings and drive pulley bearings.

Why machines get noisier with use

Here are 9 reasons why machines of all types may get noisier with use.

1. Worn or chipped gear teeth - worn or chipped teeth will not mesh properly. The shiny wear marks are often visible on the teeth.
2. Worn bearings - bearing wear will show up as vibration and noise, as flat spots or cracks appear in the balls.
3. Slackness between worn or loose parts - this appears as rattling noises, squealing from slack drive belts, "piston slap" in motors, air leaks, etc.
4. Poor lubrication - this appears as squeaking noises due to friction or excess impact noise in dry and worn gears or bearings.
5. Imbalance in rotating parts - just like your car wheels, any imbalance in a fan impeller or motor shaft will show up as excess vibration.
6. Obstruction in airways - a build-up of dirt or a bent/damaged piece of metal in an airway or near a moving part, e.g., a bent fan guard, can cause whistling or other "air" type noises. Blunt blades or cutting faces - blunt or chipped saw teeth, drill bits, router bits etc, usually make the job noisier as well as slower.
7. Damaged silencers - silencers for air-driven machines or mufflers for engines may become clogged with dirt, rusted out or damaged, so losing their ability to absorb noise.
8. Removal of a noise-reducing attachment - mufflers, silencers, covers, guards, vibration isolators etc. which reduce noise should never be removed except during maintenance, and then must be replaced.

How can I tell when my machine needs servicing?

Obviously you won't want to wait till Point D on the curve before you realize the need for servicing. There are three simple ways you can check whether any of the nine problems above are starting to appear.

Appendix F

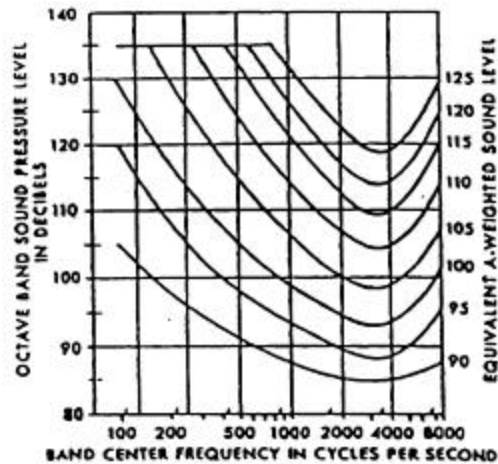
1. Look - can you see signs of wear? Is the machine's performance down? Remember, however, that only qualified people may take an electrical machine apart.
2. Feel - some of the problems will show up as looseness or increased vibration, which you can learn to recognize by feel, especially in hand-held machines. Again, only touch the machine where you can do so safely.
3. Listen - your ears are a good fault detector - even with hearing protectors on. Listen for new noises, especially tonal ("whining") sounds, repeated impacts, or high frequency ("screech") sounds. Also, slipping belts will cause a screech at start-up, while a damaged bearing may appear as a "clunk" during run-down.

Ideally, your workplace should have in place a system for checking and servicing the various machines and power tools. If you don't have the expertise in your workplace, then use a qualified service center in your area.

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OCCUPATIONAL NOISE EXPOSURE

1910.95 OCCUPATIONAL NOISE EXPOSURE.



(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table G-16 when measured on the A scale of a standard sound level meter at slow response. When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined as follows:

Equivalent sound level contours. Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on this graph and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table 1.G-16.

(b)

(1) When employees are subjected to sound exceeding those listed in Table G-16, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of Table G-16, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

(2) If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous.

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OCCUPATIONAL NOISE EXPOSURE

Oregon Administrative Rules
Oregon Occupational Safety
and Health Division

Table G-16 B Permissible Noise Exposures ¹

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
12	102
1	105
2	110
3 or less	115

¹ When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 + \dots + C_n/T_n$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. C_n indicates the total time of exposure at a specified noise level, and T_n indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

(c) Hearing conservation program.

(1) The employer shall administer a continuing, effective hearing conservation program, as described in paragraphs (c) through (o) of this section, whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A scale (slow response) or, equivalently, a dose of fifty percent. For purposes of the hearing conservation program, employee noise exposures shall be computed in accordance with Appendix A and Table G-16a, and without regard to any attenuation provided by the use of personal protective equipment.

(2) For purposes of paragraphs (c) through (n) of this section, an 8-hour time-weighted average of 85 decibels or a dose of fifty percent shall also be referred to as the action level.

(d) Monitoring.

(1) When information indicates that any employee's exposure may equal or exceed an 8-hour time-weighted average of 85 decibels, the employer shall develop and implement a monitoring program.

(i) The sampling strategy shall be designed to identify employees for inclusion in the hearing conservation program and to enable the proper selection of hearing protectors.

OCCUPATIONAL NOISE EXPOSURE

(ii) Where circumstances such as high worker mobility, significant variations in sound level, or a significant component of impulse noise make area monitoring generally inappropriate, the employer shall use representative personal sampling to comply with the monitoring requirements of this paragraph unless the employer can show that area sampling produces equivalent results.

(2)

(i) All continuous, intermittent and impulsive sound levels from 80 decibels to 130 decibels shall be integrated into the noise measurements.

(ii) Instruments used to measure employee noise exposure shall be calibrated to ensure measurement accuracy.

(3) Monitoring shall be repeated whenever a change in production, process, equipment or controls increases noise exposures to the extent that:

(i) Additional employees may be exposed at or above the action level; or

(ii) The attenuation provided by hearing protectors being used by employees may be rendered inadequate to meet the requirements of paragraph (j) of this section.

(e) Employee notification. The employer shall notify each employee exposed at or above an 8-hour time-weighted average of 85 decibels of the results of the monitoring.

(f) Observation of monitoring. The employer shall provide affected employees or their representatives with an opportunity to observe any noise measurements conducted pursuant to this section.

(g) Audiometric testing program.

(1) The employer shall establish and maintain an audiometric testing program as provided in this paragraph by making audiometric testing available to all employees whose exposures equal or exceed an 8-hour time-weighted average of 85 decibels.

(2) The program shall be provided at no cost to employees.

NOTE: 1910.95(g)(3) was NOT adopted by OR-OSHA because in Oregon, only CAOHC-certified technicians, audiologists, otolaryngologist or physicians may perform audiometric examinations. In Oregon, OAR 437-002-0095 applies:

437-002-0095 Audiometric Testing in Oregon. Audiometric tests shall be performed by a licensed or certified audiologist, otolaryngologist, or other physician, or by a technician who is certified by the Council of Accreditation in Occupational Hearing Conservation. A technician who performs audiometric tests must be responsible to an audiologist, otolaryngologist or physician.

NOTE: Technicians currently certified by OR-OSHA may continue to use their Oregon certificates until they expire, or until July 1, 1996, whichever occurs first.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: OR-OSHA Admin. Order 4-1993, f. 4/1/93, ef. 5/1/93.

(4) All audiograms obtained pursuant to this section shall meet the requirements of Appendix C: Audiometric Measuring Instruments.

(5) Baseline audiogram.

(i) Within 6 months of an employee's first exposure at or above the action level, the employer shall establish a valid baseline audiogram against which subsequent audiograms can be compared.

NOTE: 1910.95(g)(5)(ii) was NOT adopted by OR-OSHA. In Oregon, no exception is made for mobile test vans.

(iii) Testing to establish a baseline audiogram shall be preceded by at least 14 hours without exposure to workplace noise. Hearing protectors may be used as a substitute for the requirement that baseline audiograms be preceded by 14 hours without exposure to workplace noise.

(iv) The employer shall notify employees of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination.

(6) Annual audiogram. At least annually after obtaining the baseline audiogram, the employer shall obtain a new audiogram for each employee exposed at or above an 8-hour time-weighted average of 85 decibels.

(7) Evaluation of audiogram.

(i) Each employee's annual audiogram shall be compared to that employee's baseline audiogram to determine if the audiogram is valid and if a standard threshold shift as defined in paragraph (g)(10) of this section has occurred. This comparison may be done by a technician.

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(ii) If the annual audiogram shows that an employee has suffered a standard threshold shift, the employer may obtain a retest within 30 days and consider the results of the retest as the annual audiogram.

(iii) The audiologist, otolaryngologist, or physician shall review problem audiograms and shall determine whether there is a need for further evaluation. The employer shall provide to the person performing this evaluation the following information:

(A) A copy of the requirements for hearing conservation as set forth in paragraphs (c) through (n) of this section;

(B) The baseline audiogram and most recent audiogram of the employee to be evaluated;

(C) Measurements of background sound pressure levels in the audiometric test room as required in Appendix D: Audiometric Test Rooms.

(D) Records of audiometer calibrations required by paragraph (h)(5) of this section.

(8) Follow-up procedures.

(i) If a comparison of the annual audiogram to the baseline audiogram indicates a standard threshold shift as defined in paragraph (g)(10) of this section has occurred, the employee shall be informed of this fact in writing, within 21 days of the determination.

(ii) Unless a physician determines that the standard threshold shift is not work related or aggravated by occupational noise exposure, the employer shall ensure that the following steps are taken when a standard threshold shift occurs:

(A) Employees not using hearing protectors shall be fitted with hearing protectors, trained in their use and care, and required to use them.

(B) Employees already using hearing protectors shall be refitted and retrained in the use of hearing protectors and provided with hearing protectors offering greater attenuation if necessary.

(C) The employee shall be referred for a clinical audiological evaluation or an otological examination, as appropriate, if additional testing is necessary or if the employer suspects that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors.

(D) The employee is informed of the need for an otological examination if a medical pathology of the ear that is unrelated to the use of hearing protectors is suspected.

(iii) If subsequent audiometric testing of an employee whose exposure to noise is less than an 8-hour TWA of 90 decibels indicates that a standard threshold shift is not persistent, the employer:

(A) Shall inform the employee of the new audiometric interpretation; and

(B) May discontinue the required use of hearing protectors for that employee.

(9) **Revised baseline.** An annual audiogram may be substituted for the baseline audiogram when, in the judgment of the audiologist, otolaryngologist or physician who is evaluating the audiogram:

(i) The standard threshold shift revealed by the audiogram is persistent; or

(ii) The hearing threshold shown in the annual audiogram indicates significant improvement over the baseline audiogram.

(10) **Standard threshold shift.**

(i) As used in this section, a standard threshold shift is a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more at 2000, 3000, and 4000 Hz in either ear.

NOTE: 1910.95(g)(10)(ii) was NOT adopted by OR-OSHA. In Oregon, no allowance may be made for presbycusis.

(h) **Audiometric test requirements.**

(1) Audiometric tests shall be pure tone, air conduction, hearing threshold examinations, with test frequencies including as a minimum 500, 1000, 2000, 3000, 4000, and 6000 Hz. Tests at each frequency shall be taken separately for each ear.

(2) Audiometric tests shall be conducted with audiometers (including micro-processor audiometers) that meet the specifications of, and are maintained and used in accordance with, American National Standard Specification for Audio-meters, S3.6-1969, which is incorporated by reference as specified in ' 1910.6.

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(3) Pulsed-tone and self-recording audiometers, if used, shall meet the requirements specified in Appendix C: Audiometric Measuring Instruments.

(4) Audiometric examinations shall be administered in a room meeting the requirements listed in Appendix D: Audiometric Test Rooms.

(5) Audiometer calibration.

(i) The functional operation of the audiometer shall be checked before each day's use by testing a person with known, stable hearing thresholds, and by listening to the audiometer's output to make sure that the output is free from distorted or unwanted sounds. Deviations of 10 decibels or greater require an acoustic calibration.

(ii) Audiometer calibration shall be checked acoustically at least annually in accordance with Appendix E: Acoustic Calibration of Audiometers. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this check. Deviations of 15 decibels or greater require an exhaustive calibration.

(iii) An exhaustive calibration shall be performed at least every two years in accordance with sections 4.1.2; 4.1.3.; 4.1.4.3; 4.2; 4.4.1; 4.4.2; 4.4.3; and 4.5 of the American National Standard Specification for Audiometers, S3.6-1969. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this calibration.

(i) Hearing protectors.

(1) Employers shall make hearing protectors available to all employees exposed to an 8-hour time-weighted average of 85 decibels or greater at no cost to the employees. Hearing protectors shall be replaced as necessary.

(2) Employers shall ensure that hearing protectors are worn:

(i) By an employee who is required by paragraph (b)(1) of this section to wear personal protective equipment; and

(ii) By any employee who is exposed to an 8-hour time-weighted average of 85 decibels or greater, and who:

NOTE: 1910.95(i)(2)(ii)(A) was NOT adopted by OR-OSHA because 1910.95(g)(5)(ii) was NOT adopted by OR-OSHA.

(B) Has experienced a standard threshold shift.

(3) Employees shall be given the opportunity to select their hearing protectors from a variety of suitable hearing protectors provided by the employer.

(4) The employer shall provide training in the use and care of all hearing protectors provided to employees.

(5) The employer shall ensure proper initial fitting and supervise the correct use of all hearing protectors.

(j) Hearing protector attenuation.

(1) The employer shall evaluate hearing protector attenuation for the specific noise environments in which the protector will be used. The employer shall use one of the evaluation methods described in Appendix B: Methods for Estimating the Adequacy of Hearing Protection Attenuation.

(2) Hearing protectors must attenuate employee exposure at least to an 8-hour time-weighted average of 90 decibels as required by paragraph (b) of this section.

(3) For employees who have experienced a standard threshold shift, hearing protectors must attenuate employee exposure to an 8-hour time-weighted average of 85 decibels or below.

(4) The adequacy of hearing protector attenuation shall be re-evaluated whenever employee noise exposures increase to the extent that the hearing protectors provided may no longer provide adequate attenuation. The employer shall provide more effective hearing protectors where necessary.

(k) Training program.

(1) The employer shall institute a training program for all employees who are exposed to noise at or above an 8-hour time-weighted average of 85 decibels, and shall ensure employee participation in such program.

(2) The training program shall be repeated annually for each employee included in the hearing conservation program. Information provided in the training program shall be updated to be consistent with changes in protective equipment and work processes.

(3) The employer shall ensure that each employee is informed of the following:

(i) The effects of noise on hearing;

(ii) The purpose of hearing protectors, the advantages, disadvantages, and attenuation of various types, and instructions on selection, fitting, use, and care; and

OCCUPATIONAL NOISE EXPOSURE

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(iii) The purpose of audiometric testing, and an explanation of the test procedures.

(l) Access to information and training materials.

(1) The employer shall make available to affected employees or their representatives copies of this standard and shall also post a copy in the workplace.

(2) The employer shall provide to affected employees any informational materials pertaining to the standard that are supplied to the employer by the Assistant Secretary.

(3) The employer shall provide, upon request, all materials related to the employer's training and education program pertaining to this standard to the Assistant Secretary and the Director.

(m) Recordkeeping.

(1) **Exposure measurements.** The employer shall maintain an accurate record of all employee exposure measurements required by paragraph (d) of this section.

(2) Audiometric tests.

(i) The employer shall retain all employee audiometric test records obtained pursuant to paragraph (g) of this section:

(ii) This record shall include:

(A) Name and job classification of the employee;

(B) Date of the audiogram;

(C) The examiner's name;

(D) Date of the last acoustic or exhaustive calibration of the audiometer; and

(E) Employee's most recent noise exposure assessment.

(F) The employer shall maintain accurate records of the measurements of the background sound pressure levels in audiometric test rooms.

(3) **Record retention.** The employer shall retain records required in this paragraph (m) for at least the following periods.

(i) Noise exposure measurement records shall be retained for two years.

(ii) Audiometric test records shall be retained for the duration of the affected employee's employment.

(4) Access to records. All records required by this section shall be provided upon request to employees, former employees, representatives designated by the individual employee, and the Assistant Secretary. The provisions of 29 CFR 1910.20(a)-(e) and (g)-(i) apply to access to records under this section.

(5) Transfer of records. If the employer ceases to do business, the employer shall transfer to the successor employer all records required to be maintained by this section, and the successor employer shall retain them for the remainder of the period prescribed in paragraph (m)(3) of this section.

(n) Appendices.

(1) Appendices A, B, C, D, and E to this section are incorporated as part of this section and the contents of these Appendices are mandatory.

NOTE: Appendix F was NOT adopted by OR-OSHA, because it pertains to presbycusis. In Oregon, no allowance is made for presbycusis (hearing loss due to aging).

(2) Appendices F and G to this section are informational and are not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

NOTE: 1910.95(o) was NOT adopted by OR-OSHA. In Oregon, this standard applies to ALL industries with no exceptions.

(p) Startup date. Baseline audiograms required by paragraph (g) of this section shall be completed by March 1, 1984.

(Approved by the Office of Management and Budget under control number 1218-0048)

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Stats. Implemented: ORS 654.001 through 654.295.

Hist: OR-OSHA Admin. Order 4-1993, f. 4/1/93, ef. 5/1/93.
OR-OSHA Admin. Order 4-1997, f. 4/2/97, ef. 4/2/97.

APPENDIX A to 1910.95 B NOISE EXPOSURE COMPUTATION

This Appendix is Mandatory

I. Computation of Employee Noise Exposure.

(1) Noise dose is computed using Table G-16a as follows:

(i) When the sound level, L , is constant over the entire work shift, the noise dose, D , in percent, is given by: $D = 100 C/T$ where C is the total length of the work day, in hours, and T is the reference duration corresponding to the measured sound level, L , as given in Table G-16a or by the formula shown as a footnote to that table.

(ii) When the workshift noise exposure is composed of two or more periods of noise at different levels, the total noise dose over the work day is given by:

$$D = 100 (C_1/T_1 + C_2/T_2 + \dots + C_n/T_n),$$

where C_n indicates the total time of exposure at a specific noise level, and T_n indicates the reference duration for that level as given by Table G-16a.

(2) The eight-hour time-weighted average sound level (TWA), in decibels, may be computed from the dose, in percent, by means of the formula: $TWA = 16.61 \log_{10} (D/100) + 90$. For an eight-hour workshift with the noise level constant over the entire shift, the TWA is equal to the measured sound level.

(3) A table relating dose and TWA is given in Section II.

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OCCUPATIONAL NOISE EXPOSURE

Oregon Administrative Rules
Oregon Occupational Safety
and Health Division

Table G-16a

A-weighted sound level, L (decibel)	Reference duration, T (hour)
80	32
81	27.9
82	24.3
83	21.1
84	18.4
85	16
86	13.9
87	12.1
88	10.6
89	9.2
90	8
91	7.0
92	6.1
93	5.3
94	4.6
95	4
96	3.5
97	3.0
98	2.6
99	2.3
100	2
101	1.7
102	1.5
103	1.3
104	1.1
105	1
106	0.87
107	0.76
108	0.66
109	0.57
110	0.5
111	0.44
112	0.38
113	0.33
114	0.29
115	0.25
116	0.22
117	0.19
118	0.16
119	0.14
120	0.125
121	0.11
122	0.095
123	0.082
124	0.072
125	0.063
126	0.054
127	0.047
128	0.041

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129	0.036
130	0.031

In the above table the reference duration, T, is computed by where L is the measured A-weighted sound level.

II. Conversion Between "Dose" and "8-Hour Time-Weighted Average" Sound Level.

Compliance with paragraphs (c)-(r) of this regulation is determined by the amount of exposure to noise in the workplace. The amount of such exposure is usually measured with an audiodosimeter which gives a readout in terms of "dose." In order to better understand the requirements of the amendment, dosimeter readings can be converted to an "8-hour time-weighted average sound level." (TWA).

In order to convert the reading of a dosimeter into TWA, see Table A-1, below. This table applies to dosimeters that are set by the manufacturer to calculate dose or percent exposure according to the relationships in Table G-16a. So, for example, a dose of 91 percent over an eight hour day results in a TWA of 89.3 dB, and, a dose of 50 percent corresponds to a TWA of 85 dB.

If the dose as read on the dosimeter is less than or greater than the values found in Table A-1, the TWA may be calculated by using the formula: $TWA = 16.61 \log_{10} (D/100) + 90$ where TWA = 8-hour time-weighted average sound level and D = accumulated dose in percent exposure.

OCCUPATIONAL NOISE EXPOSURE



**Table A-1 B Conversion from "Percent Noise Exposure" or "Dose" to
"8-Hour Time-Weighted Average Sound Level" (TWA)**

Dose or percent noise exposure	TWA	Dose or percent noise exposure	TWA	Dose or percent noise exposure	TWA
10	73.4	117	91.1	520	101.9
15	76.3	118	91.2	530	102.0
20	78.4	119	91.3	540	102.2
25	80.0	120	91.3	550	102.3
30	81.3	125	91.6	560	102.4
35	82.4	130	91.9	570	102.6
40	83.4	135	92.2	580	102.7
45	84.2	140	92.4	590	102.8
50	85.0	145	92.7	600	102.9
55	85.7	150	92.9	610	103.0
60	86.3	155	93.2	620	103.2
65	86.9	160	93.4	630	103.3
70	87.4	165	93.6	640	103.4
75	87.9	170	93.8	650	103.5
80	88.4	175	94.0	660	103.6
81	88.5	180	94.2	670	103.7
82	88.6	185	94.4	680	103.8
83	88.7	190	94.6	690	103.9
84	88.7	195	94.8	700	104.0
85	88.8	200	95.0	710	104.1
86	88.9	210	95.4	720	104.2
87	89.0	220	95.7	730	104.3
88	89.1	230	96.0	740	104.4
89	89.2	240	96.3	750	104.5
90	89.2	250	96.6	760	104.6
91	89.3	260	96.9	770	104.7
92	89.4	270	97.2	780	104.8
93	89.5	280	97.4	790	104.9
94	89.6	290	97.7	800	105.0
95	89.6	300	97.9	810	105.1
96	89.7	310	98.2	820	105.3
97	89.8	320	98.4	830	105.4
98	89.9	330	98.6	840	105.4
99	89.9	340	98.8	850	105.5
100	90.0	350	99.0	860	105.6
101	90.1	360	99.2	870	105.7
102	90.1	370	99.4	880	105.8
103	90.2	380	99.6	890	105.8
104	90.3	390	99.8	900	105.9
105	90.4	400	100.0	910	106.0
106	90.4	410	100.4	920	106.1
107	90.5	420	100.5	930	106.2
108	90.6	430	100.7	940	106.2
109	90.6	440	100.8	950	106.3
110	90.7	450	101.0	960	106.4
111	90.8	460	101.2	970	106.5
112	90.8	470	101.3	980	106.5
113	90.9	480	101.5	990	106.6
114	90.9	490	101.6	999	
115	91.1	500	101.8		
116	91.1	510			

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).
Hist: OR-OSHA Admin. Order 4-1993, f. 4/1/93, ef. 5/1/93.

**APPENDIX B to 1910.95 B METHODS FOR ESTIMATING THE ADEQUACY OF
HEARING PROTECTOR ATTENUATION****This Appendix is Mandatory**

For employees who have experienced a significant threshold shift, hearing protector attenuation must be sufficient to reduce employee exposure to a TWA of 85 dB. Employers must select one of the following methods by which to estimate the adequacy of hearing protector attenuation.

The most convenient method is the Noise Reduction Rating (NRR) developed by the Environmental Protection Agency (EPA). According to EPA regulation, the NRR must be shown on the hearing protector package. The NRR is then related to an individual worker's noise environment in order to assess the adequacy of the attenuation of a given hearing protector. This Appendix describes four methods of using the NRR to determine whether a particular hearing protector provides adequate protection within a given exposure environment. Selection among the four procedures is dependent upon the employer's noise measuring instruments.

Instead of using the NRR, employers may evaluate the adequacy of hearing protector attenuation by using one of the three methods developed by the National Institute for Occupational Safety and Health (NIOSH), which are described in the "List of Personal Hearing Protectors and Attenuation Data," HEW Publication No. 76-120, 1975, pages 21-37. These methods are known as NIOSH methods #1, #2 and #3. The NRR described below is a simplification of NIOSH method #2. The most complex method is NIOSH method #1, which is probably the most accurate method since it uses the largest amount of spectral information from the individual employee's noise environment. As in the case of the NRR method described below, if one of the NIOSH methods is used, the selected method must be applied to an individual's noise environment to assess the adequacy of the attenuation. Employers should be careful to take a sufficient number of measurements in order to achieve a representative sample for each time segment.

NOTE: The employer must remember that calculated attenuation values reflect realistic values only to the extent that the protectors are properly fitted and worn.

When using the NRR to assess hearing protector adequacy, one of the following methods must be used:

- (i) When using a dosimeter that is capable of C-weighted measurements:
 - (A) Obtain the employee's C-weighted dose for the entire workshift, and convert to TWA (see Appendix A, II).
 - (B) Subtract the NRR from the C-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(ii) When using a dosimeter that is not capable of C-weighted measurements, the following method may be used:

- (A) Convert the A-weighted dose to TWA (see Appendix A).
- (B) Subtract 7 dB from the NRR.
- (C) Subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(iii) When using a sound level meter set to the A-weighting network:

- (A) Obtain the employee's A-weighted TWA.
- (B) Subtract 7 dB from the NRR, and subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(iv) When using a sound level meter set on the C-weighting network:

- (A) Obtain a representative sample of the C-weighted sound levels in the employee's environment.
- (B) Subtract the NRR from the C-weighted average sound level to obtain the estimated A-weighted TWA under the ear protector.

(v) When using area monitoring procedures and a sound level meter set to the A-weighting network.

- (A) Obtain a representative sound level for the area in question.
- (B) Subtract 7 dB from the NRR and subtract the remainder from the A-weighted sound level for that area.

(vi) When using area monitoring procedures and a sound level meter set to the C-weighting network:

- (A) Obtain a representative sound level for the area in question.
- (B) Subtract the NRR from the C-weighted sound level for that area.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: OR-OSHA Admin. Order 4-1993, f. 4/1/93, ef. 5/1/93.

APPENDIX C to '1910.95 B AUDIOMETRIC MEASURING INSTRUMENTS**This Appendix is Mandatory**

1. In the event that pulsed-tone audiometers are used, they shall have a tone on-time of at least 200 milliseconds.
2. Self-recording audiometers shall comply with the following requirements:
 - (A) The chart upon which the audiogram is traced shall have lines at positions corresponding to all multiples of 10 dB hearing level within the intensity range spanned by the audiometer. The lines shall be equally spaced and shall be separated by at least 1/4 inch. Additional increments are optional. The audiogram pen tracings shall not exceed 2 dB in width.
 - (B) It shall be possible to set the stylus manually at the 10-dB increment lines for calibration purposes.
 - (C) The slewing rate for the audiometer attenuator shall not be more than 6 dB/sec except that an initial slewing rate greater than 6 dB/sec is permitted at the beginning of each new test frequency, but only until the second subject response.
 - (D) The audiometer shall remain at each required test frequency for 30 seconds ($\sqrt{3}$ seconds). The audiogram shall be clearly marked at each change of frequency and the actual frequency change of the audiometer shall not deviate from the frequency boundaries marked on the audiogram by more than $\sqrt{3}$ seconds.
 - (E) It must be possible at each test frequency to place a horizontal line segment parallel to the time axis on the audiogram, such that the audiometric tracing crosses the line segment at least six times at that test frequency. At each test frequency the threshold shall be the average of the midpoints of the tracing excursions.

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: OR-OSHA Admin. Order 4-1993, f. 4/1/93, ef. 5/1/93.

APPENDIX D to 1910.95 B AUDIOMETRIC TEST ROOMS

This Appendix is Mandatory

Rooms used for audiometric testing shall not have background sound pressure levels exceeding those in Table D1 when measured by equipment conforming at least to the Type 2 requirements of American National Standard Specification for Sound Level Meters, S1.4-1971 (R1976), and to the Class II requirements of American National Standard Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets, S1.11-1971 (R1976).

**Table D-1 B Maximum Allowable Octave-Band Sound
Pressure Levels for Audiometric Test Rooms**

Octave-band center frequency (Hz)	500	1000	2000	4000	8000
Sound pressure level (dB)	40	40	47	57	62

Stat. Auth.: ORS 654.025(2) and ORS 656.726(3).

Hist: OR-OSHA Admin. Order 4-1993, f. 4/1/93, ef. 5/1/93.



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