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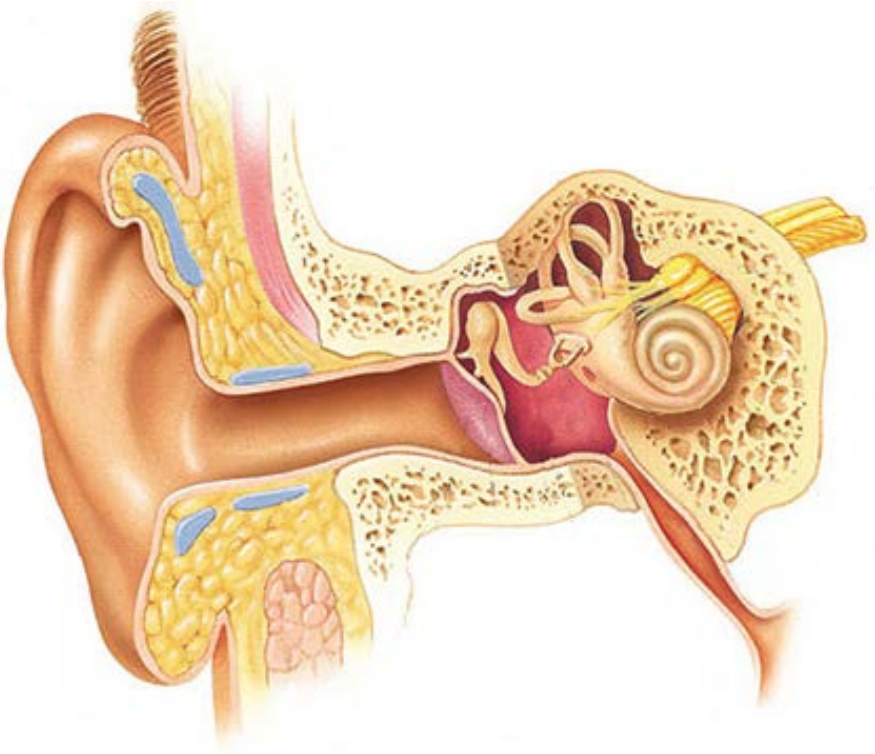
Hearing Conservation

Self-Study #12350



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Contents

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Contents

Lessons Learned

Unanalyzed Job Activity Results in Worker Overexposure to Noise

In 2015 at the Y-12 National Security Complex, noise monitoring was performed at a production facility. During monitoring, a chemical operator performed the undocumented job activity of striking the outside of a metal hopper with a rubber mallet to dislodge material stuck within the hopper. The undocumented activity was performed twice during the monitoring period, and monitoring results indicated that the chemical operator was exposed to noise levels that exceeded the exposure limit.

The undocumented activity that produced the high noise level was considered "skill of craft," so it was not addressed in the procedure or the job hazard analysis (JHA). Prior noise monitoring had not revealed the hazard because the activity of striking the hopper was performed intermittently and had not been captured during previous monitoring events.

Lesson Learned and Action Taken

Workers and management must recognize that "skill-of-craft" work that has not been addressed in a JHA may introduce additional hazards, such as exposure to noise. A questioning attitude should be used to recognize and respond to such potential hazards. As part of the actions taken after the event, an evaluation was performed that focused on reducing noise associated with the process. This included eliminating the need to strike the hopper to dislodge material.

-paraphrased from Y-2015-OR-Y12-7735

Introduction

Course Overview

Occupational hearing loss is one of the most common work-related illnesses in the United States (US). From 22 to 30 million US workers are exposed to hazardous noise levels at work, and 25% of these workers will develop permanent hearing loss. Hearing loss from noise is slow and painless, and you can have a disability before you notice it. This course presents the hazards associated with workplace noise, the purpose and elements of the Los Alamos National Laboratory (LANL) Hearing Conservation Program (HCP), and controls that are available to reduce your exposure to hazardous levels of noise.

Course Objectives

After completing this course, you will be able to recognize

- how hearing works and the effects of noise on hearing,
- noise levels that are considered hazardous,
- the purpose and elements of the LANL HCP,
- controls used to reduce your exposure to noise, and
- actions you can take to conserve your hearing.

Target Audience

See pages 10 - 11 for information about the LANL OEL.

This course (#12350) or *Hearing Conservation Live* (#2430) must be completed annually by workers exposed to workplace noise at or above the LANL occupational exposure level (OEL). Those workers must also be entered into the LANL Hearing Conservation Program to meet the requirements of LANL P101-31, *Hearing Conservation/Noise Program*.

Note: *Vendors and subcontractors are excluded from the requirements of P101-31 but they must still follow Occupational Safety and Health Administration (OSHA) requirements for occupational noise as directed in their contract.*

Program Owner

This course was developed under the direction and technical oversight of Occupational Safety and Health-Industrial Safety and Hygiene (OSH-ISH), the functional program owner for this training.

Course Limitations

This course has the following limitations:

- Successful completion of this course does not enroll you in the LANL Hearing Conservation/Noise Program. Your supervisor can assist you with enrollment in the HCP.
- This course does not supply workers with hearing protection devices.

About This Course

To receive credit in UTrain for completing this course, you must score 80% or better on the 15-question quiz. Directions for initiating the quiz are found at the end of this training manual.

This self-study course may contain links to LANL websites. UTrain might not support active links, so please copy and paste the links into the address line in your browser.

Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
ANR	active noise reduction
CFR	Code of Federal Regulations
dB	decibel
DIY	do it yourself
HCP	Hearing Conservation/Noise Program
HPD	hearing protection device
JHA	job hazard analysis
LANL	Los Alamos National Laboratory
NIHL	noise-induced hearing loss
NRR	noise reduction rating
OEL	occupational exposure limit
OSHA	Occupational Safety and Health Administration
P	procedure
PPE	personal protective equipment
SLM	sound level meter
TLV	threshold limit value
TWA	time-weighted average

Module 1: Basics of Hearing and Hearing Loss

Module Objectives

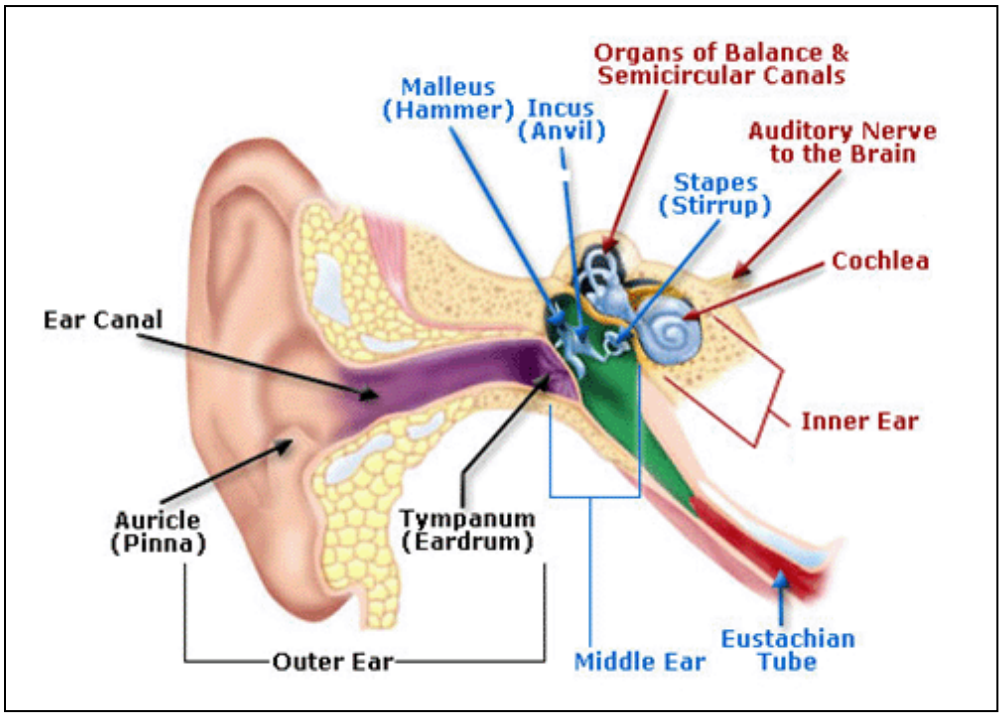
After completing this module, you will be able to recognize

- the basic anatomy and function of the human ear,
- causes of hearing loss and the consequences of overexposure to noise,
- typical noise levels that can cause hearing loss, and
- warning signs of hearing loss.

Anatomy and Function of the Human Ear

Anatomy of the Ear

The human ear is composed of the outer ear, the middle ear, and the inner ear.



Major parts of the human ear

How the Ear Works

Sound waves enter the outer ear and are channeled through the auditory canal to the eardrum. The vibrations impact the eardrum and are transmitted to the middle and inner ear. In the middle ear, three small bones (the malleus, the incus, and the stapes) amplify and transmit the vibrations generated by the sound to the inner ear. The inner ear contains a snail-like structure called the cochlea, which is filled with fluid and lined with cells with very fine hairs. These microscopic hairs move with the vibrations and convert the sound waves into nerve impulses, which result in the sounds we hear.

The table below lists the parts of the ear and their functions.

Structure and Function of the Human Ear		
Structure	**Part**	**Function**
outer ear	pinna—the external, skin-covered flap of cartilage	The pinna captures sound waves and directs them into the auditory canal.
	auditory canal	The auditory canal channels sound from the pinna to the eardrum.
middle ear	eardrum (tympanum) three bones: malleus (hammer) incus (anvil) stapes (stirrup)	Pressure vibrations created by soundwaves in the auditory canal strike the eardrum, which transmits them to the three ear bones. The bones, in turn, create mechanical vibrations that are passed on to the inner ear.
	eustachian tube	The eustachian tube connects the middle ear to the throat and helps regulate air pressure on either side of the eardrum.
inner ear	cochlea	The cochlea contains tiny hairlike cells in fluid (about 35,000 in a young, healthy ear). The cells respond to vibrations in the fluid, passing the sensations to nerve fibers in the auditory nerve.
	auditory nerve	The auditory nerve transmits impulses from the inner ear to the brain, resulting in what is known as hearing.
	semicircular canals	The semicircular canals influence our sense of balance.

Causes of Hearing Loss

Genetics and childhood diseases can increase your risk of hearing loss. Hearing loss also occurs from aging (presbycusis).

Noise is defined as unwanted sound. Overexposure to noise can cause noise-induced hearing loss (NIHL). This course focuses on NIHL caused by occupational exposures to elevated levels of noise.

Noise-Induced Hearing Loss

NIHL in the workplace has two causes:

- ***acoustic trauma*** can cause NIHL as a result of a one-time exposure to a single loud sound, such as a gunshot. The sudden pressure wave can immediately damage structures in the ear, including rupturing the eardrum, dislocating middle-ear bones, and/or injuring the hairlike cells in the inner ear (cochlear damage).
- ***gradually developing NIHL*** refers to damage to the hairlike cells in the inner ear from repeated exposure to loud sounds over a long period of time. Long-term exposure to sounds that are loud but not necessarily intense enough to cause acoustic trauma can cause NIHL. It may take many years before a worker notices gradually developing NIHL.

Exposure to Ototoxins

Ototoxins are chemicals or metals that may cause hearing loss and that may speed up hearing loss in the presence of noise. In areas where workers are exposed to both high noise and ototoxins, hearing loss may be greater than that caused by exposure to noise alone. Exposure to ototoxins may occur through inhalation, ingestion, absorption, or contact. Examples of ototoxins in the workplace include carbon monoxide, lead, manganese, styrene, toluene, and xylene. Ototoxic medications, such as certain antibiotics, can also cause temporary or permanent hearing loss.

Note: *If you have a concern about ototoxins in your work area, contact your area industrial hygienist or Occupational Safety and Health at 606-0295.*

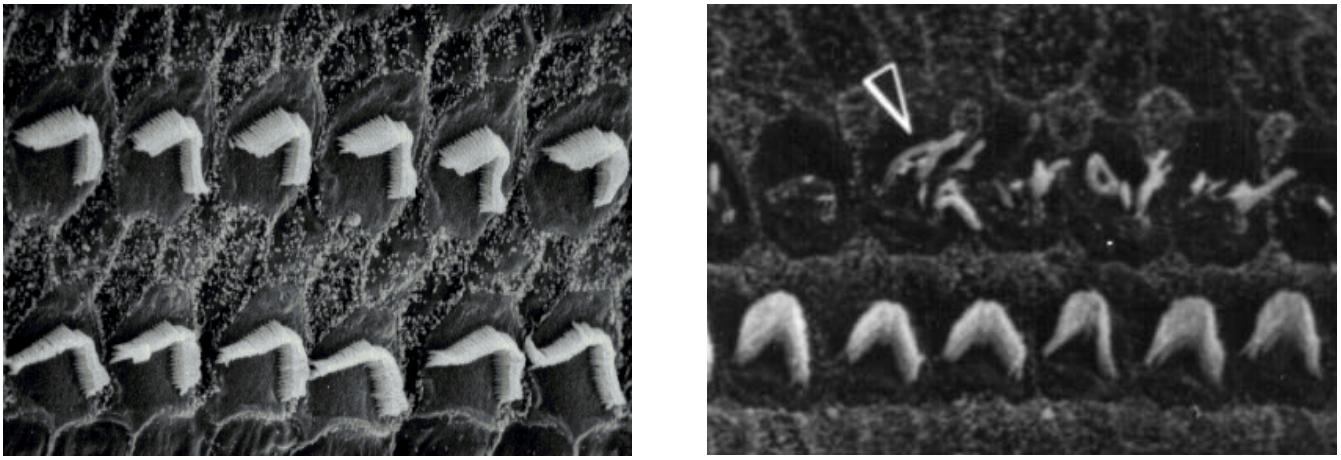
Consequences of Overexposure to Noise

Workplace noise can also cause mental or physical stress, reduce productivity, interfere with concentration, and increase the risk of adverse events (accidents) by making it hard to communicate.

NIHL can be temporary or permanent.

Temporary hearing loss (temporary threshold shift) can result from exposure to a single high-noise event, such as from a loud concert or from working in a high-noise area without adequate hearing protection. Temporary hearing loss is reversible, and normal hearing usually returns within 16 hours when given a period of quiet that allows healing. It is difficult to predict how many times a person can sustain temporary hearing loss before permanent hearing loss occurs. However, the likelihood of permanent hearing loss increases with repeated exposure to excessive noise.

Permanent hearing loss (permanent threshold shift) occurs when, overstimulated by noise for an extended period of time (often years), the hairlike cells in the inner ear lose their responsiveness and their ability to recover. In such cases, no amount of rest and quiet time will help restore that portion of the hearing that is lost.



Photos of hair cells in the inner ear. The photo on the right shows the upper row of hairs completely destroyed by exposure to excessive noise.

Tinnitus (ringing in the ears) is a disturbance produced by the inner ear and interpreted by the brain as sound. Persons with tinnitus describe it as a hum, buzz, roar, ring, or whistle, which can be temporary or permanent. Tinnitus can occur after long-term exposure to high sound levels and sometimes from short-term exposure to very high sound levels.

Because the human ear cannot block out unwanted or excessive noise, you must take an active role to protect your hearing and avoid permanent hearing loss. NIHL is preventable, but once it becomes permanent, it is irreversible.

Noise Levels and Hearing Loss

Decibels are logarithmic-based units that allow a wide range of noise to be measured.

Noise intensity, or loudness, is measured using a sound level meter (SLM) and is reported in decibels (dBs). The measuring is done using either an A scale or a C scale of the SLM. These scales measure sound intensity as a function of the frequency of the sound, and their values are reported as dBA and dBC, respectively.

The level of noise that causes hearing loss can vary from person to person. As a general rule, sound levels below 75 dBA are unlikely to damage hearing. Repeated exposure to noise above 85 dBA for extended periods of time can lead to permanent hearing loss.

"Painless" hearing loss can occur from exposure to noise levels between 85 and 125 dBA. You may not be aware of this damage as it occurs, but the damage can result in permanent hearing loss. The table below lists typical sources and levels of noise.

Approximate Noise Levels from Various Sources

Source	dB	Source	dB
M-16 rifle	160	Motorcycle at 60 mph (with helmet)	106
12-gauge shotgun	140	Lawn mower	90
Jet engine	140	Busy traffic	80
Threshold of pain	**140**	Noisy office	75
Threshold of discomfort	**120**	Normal conversation	60
Aircraft propeller	120	Private office	45
Motorcycle at 60 mph (without helmet)	113	Soft music	40
Power saw	110	Rustle of a leaf	10
Plate fabrication shop	100		

If you must shout to communicate, the noise in your work-place is loud enough to cause hearing damage.

Any of the following could indicate that the noise in your workplace is loud enough to cause hearing damage:

- you must shout to communicate,
- your ears ring or buzz after exposure to noise,
- you cannot hear high-pitched sounds, or
- speech seems muffled after exposure.

Use the **3-foot rule** to get a quick idea if noise is too loud. If you have to shout to someone standing 3 feet from you, then you are in a noisy area!

Warning Signs of Hearing Loss

Warning signs of hearing loss may include

- ringing in the ears;
- stuffiness;
- temporary hearing dullness;
- difficulty understanding words when there is background noise (such as a crowd of people);
- trouble hearing consonants, such as “S” and “T”;
- frequently asking others to speak louder or more slowly;
- trouble hearing high-frequency sounds such as whistles or ringing telephones;
- needing to turn up the volume of the television or radio;
- withdrawal from conversations; and
- avoidance of some social settings.

***Note**: If you are experiencing any of these symptoms and are regularly exposed to loud workplace noise, arrange for a medical evaluation and try to reduce your noise exposure.*

Questions to consider if you or someone you know may be experiencing hearing loss.

Do you have a problem hearing over the telephone?

Do you have trouble following the conversation when two or more people are talking at the same time?

Do people complain that you turn the TV volume up too high?

Do you have to strain to understand conversation?

Do you have trouble hearing in a noisy environment?

Do you find yourself asking people to repeat themselves?

Do many people you talk to seem to mumble (or to not speak clearly)?

Do you misunderstand what others are saying and respond inappropriately?

Do you have trouble understanding the speech of women and children?

Do people get annoyed because you misunderstand what they say?

Module 2: LANL Hearing Conservation Program

Module Objectives

After completing this module, you will be able to recognize

- the purpose and elements of the Los Alamos National Laboratory (LANL) Hearing Conservation Program (HCP),
- the LANL occupational exposure limits (OELs) for noise,
- methods used to evaluate noise in the workplace, and
- the purpose of and the procedure for audiometric testing.

Purpose of the LANL HCP

The purpose of the LANL HCP is to protect workers from potential adverse health effects from exposure to noise that exceeds the LANL OELs. The elements and requirements of the LANL HCP are outlined in P101-31, *Hearing Conservation/Noise Program*. P101-31 contains requirements from

P101-31 can be accessed from the LANL homepage.

OSHA 29 CFR 1910.95 can be accessed for free online.

- OSHA 29 CFR 1910.95, *Occupational Noise Exposure;* and
- the 2005 American Conference of Governmental Industrial Hygienists (ACGIH) *Threshold Limit Values (TLVs) for Noise*.

***Note**: Vendors and subcontractors are excluded from the requirements of P101-31, but they must still follow OSHA requirements for occupational noise as directed in their contract.*

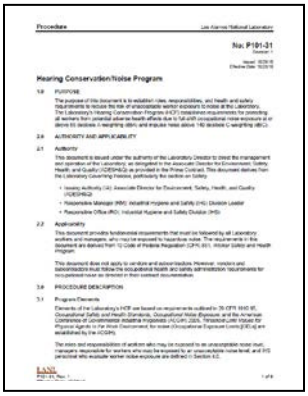
Worker Overexposed to Noise during Compressed Gas Release

In October 2009 at Brookhaven National Laboratory, a rigger was walking past the Relativistic Heavy Ion Collider Compressor Building. As he walked past the vertical liquid nitrogen tanks located outside the building, cold helium gas was released from a vent approximately 14 feet above the ground. The noise caused by the release startled the rigger and resulted in a serious injury. Subsequent testing showed that the maximum noise level from venting the gas was 144.9 dB. The worker was exposed to a noise level that exceeded ACGIH threshold limit values (TLVs) for both time-weighted average (TWA) and peak event.

Among actions taken, controls were put in place to ensure personnel were clear of the area before any helium was vented.

-paraphrased from Lesson ID: 2009-BNL-HP-0001

Elements of the LANL HCP


Procedure — Los Alamos National Laboratory

No. P101-31

Hearing Conservation/Noise Program

1.0 PURPOSE

2.0 AUTHORITY AND APPLICABILITY

2.1 Authority

2.2 Applicability

3.0 PROCEDURE DESCRIPTION

3.1 Program Elements

LANL

Elements of the LANL HCP include

- Monitoring. Workers' noise exposure is measured, and workers are identified for inclusion in the HCP. Affected workers or their authorized representatives must have an opportunity to observe noise monitoring.
- Employee notification. Each worker who is exposed at or above an 8-hour time-weighted average (TWA) of 85 dB must be notified of monitoring results.
- Audiometric testing. Workers whose exposures meet or exceed an 8-hour TWA of 85 dB are given annual audiometric testing.
- Noise controls. Engineering and administrative controls must be considered in areas where workers are subjected to noise exceeding the OEL, and suitable hearing protection devices (HPDs) must be made available to workers who are exposed to noise at or above the OEL. Workers who are exposed to noise levels that meet or exceed the LANL OEL for workplace noise must wear hearing protection.
- Training. Annual hearing conservation training is required*.
- Recordkeeping. Records of noise exposure assessments and audiometric tests are maintained and are provided to workers upon request.

*__Note:__ Either this course (#2430) or *Hearing Conservation Self-Study* (#12350) must be completed annually to meet the training requirements of LANL P101-31.

LANL Occupational Exposure Levels

Noise in the workplace is normally measured with special filters and is indicated as **dBA or dBC**. Sound-level meters set to dBA or dBC respond differently to certain frequencies. The dBA scale is weighted to represent the human ear's response to sound.

LANL has adopted allowable noise levels in the workplace based on the 2005 ACGIH TLVs.

The LANL occupational exposure limit (OEL) for steady-state noise is an 85-dBA, 8-hour time-weighted average (TWA). Participation in the HCP is mandatory for workers who are exposed to noise levels that meet or exceed the LANL OEL for workplace noise. Workers who are exposed to noise levels that meet or exceed the LANL OEL for workplace noise must wear hearing protection.

The LANL exchange rate of 3 dB is more conservative than the OSHA exchange rate of 5 dB.

LANL uses an **exchange rate** of 3 dB. The exchange rate is the number of decibels that represents a doubling (or a halving) of the sound intensity. This means that at LANL, a decibel level of 88 would be twice the intensity of a decibel level of 85. As shown in the table below, worker exposure to 88 dBA cannot exceed a 4-hour TWA, exposure to 91 dBA cannot exceed a 2-hour TWA, etc.

No exposure of an unprotected ear in excess of a peak sound pressure level of 140 dBC should be permitted.

LANL OELs for Noise*	
Duration per Day (hours)	**Sound Level (dBA)**
24	80
16	82
8	85
4	88
2	91
1	94
½	97
¼	100
*Based on 2005 ACGIH TLVs, where a more extensive table can be found.	

Workplace Evaluations and Audiometric Exams

Workplace Evaluations

An SLM *(above)* measures the level of noise emitted by noise sources.

An industrial hygienist will measure the levels of noise in your work area. Personnel exposed to hazardous levels of noise will be notified and enrolled in the HCP. SLMs and noise dosimeters are two types of instruments that industrial hygienists use to measure noise in the workplace.

Sound-level meters (SLMs) are used to identify noise sources and to measure the level of noise emitted by such sources.

Industrial hygienist using an SLM *(right).*

Noise dosimeters measure the amount of noise that a worker is exposed to during a period of time (usually a workday). A noise dosimeter is useful when the worker's job requires that work be performed in several areas that may have a variety of noise levels.

Noise dosimeters are used to measure worker exposure to noise.

Audiometric Testing

Audiometric Testing

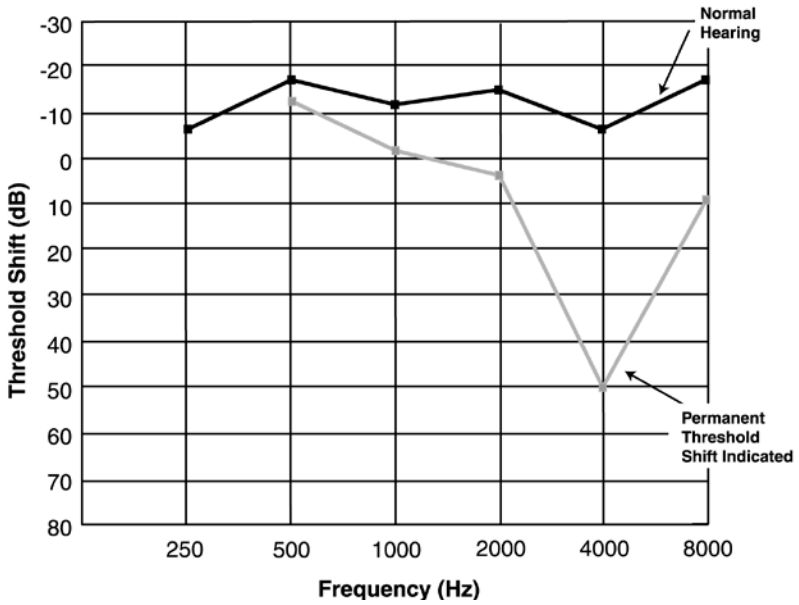
Occupational Medicine (OccMed) personnel perform audiometric testing for personnel enrolled in the LANL HCP and determine if followup care is needed. An audiometric exam is used to evaluate your hearing using a series of frequencies (tones) and decibels (loudness). An audiogram is the record of your audiometric exam. Once enrolled in the HCP, you will receive a ***baseline audiogram*** within 6 months of your first exposure at or above the LANL OEL and an ***annual audiogram*** every year thereafter.

Before receiving your baseline audiogram, you must avoid high levels of noise for at least 14 hours or wear hearing protection during this time if you must work in a noisy area. In contrast, an annual audiogram may be scheduled well into the work shift so that comparisons with baseline audiograms will reveal any early indications of hearing loss or temporary threshold shifts.

Audiograms can be used to detect hearing loss at frequencies that may not be noticeable to you. By comparing your baseline audiogram with subsequent annual audiograms, OccMed personnel can determine whether your hearing is changing over time and detect whether any progressive hearing loss is occurring. In some cases, an OccMed physician may request that a consulting audiologist provide followup medical care or an additional evaluation.

During an audiometric exam, you will sit in a booth and wear headphones while your hearing in each ear is tested.

An example of audiogram comparison is shown below. In this example, permanent hearing loss (a permanent threshold shift) may be indicated at a frequency of 4000 hertz (Hz).



Comparison of an audiogram showing normal hearing with an audiogram indicating a permanent threshold shift.

For recordkeeping purposes, NIHL is defined 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, where the employee's total hearing level is 25 decibels (dB) or more above the audiometric zero (also averaged at 2000, 3000, and 4000 hertz) in the same ear(s).

Access to Records

Workplace noise exposure records at LANL are considered permanent records and are retained for life by Occupational Safety and Health. Audiograms are kept on file by OccMed for the duration of your employment. These records must be provided to you or to representatives designated by you upon your request.

Module 3: Protecting Your Hearing

Module Objectives

After completing this module, you will be able to recognize

- engineering and administrative controls that can help to preserve your hearing;
- advantages and disadvantages of various types of HPDs;
- factors that affect the efficiency of HPDs use and how to care for HPDs; and
- actions you can take to protect your hearing and whom to contact to report suspected noise hazards.

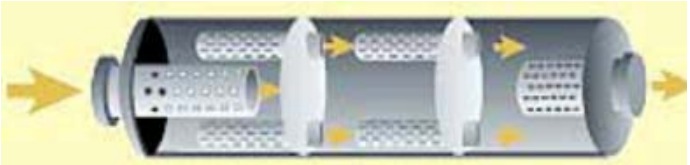
Engineering and Administrative Controls

Before buying equipment or changing a process, talk to an industrial hygienist about the noise hazards that may be created and the controls that may be needed.

Engineering controls are mechanical, structural, or electrical systems used to reduce workplace noise exposures and prevent occupational NIHL whenever technologically and economically feasible. Engineering controls include

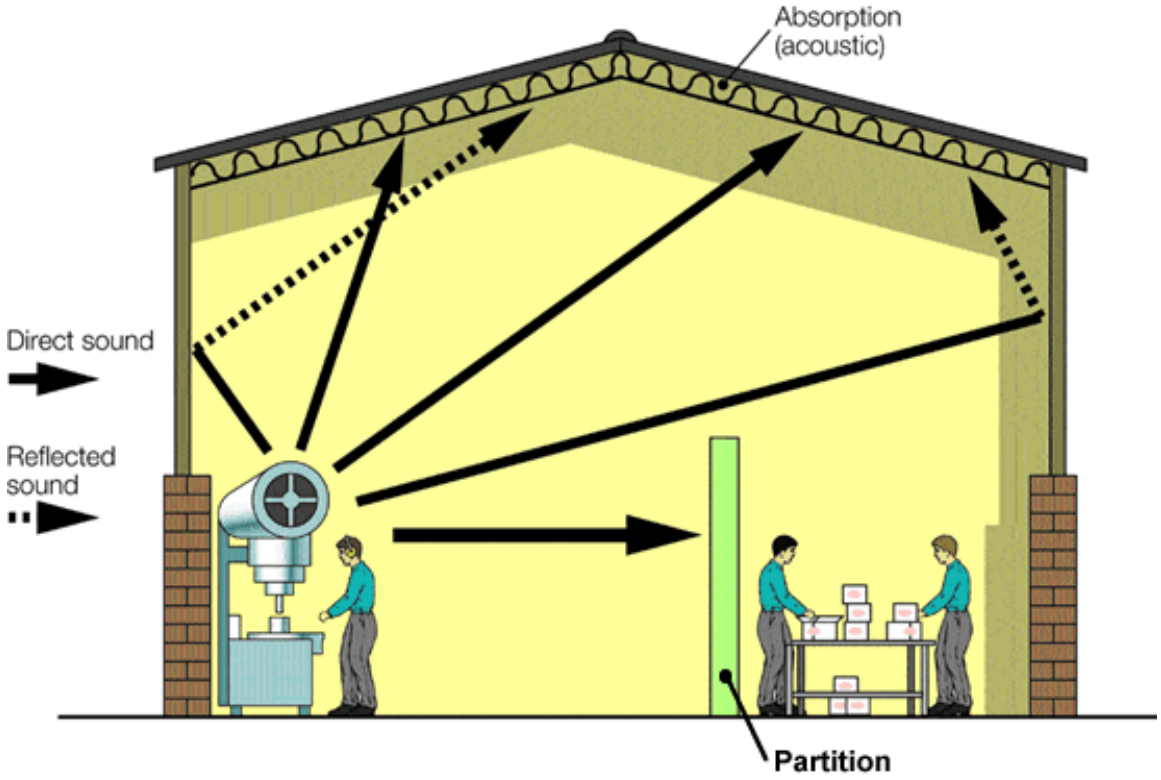
- ***enclosures*** that surround noise sources or personnel work areas;

Enclosures can be used for noise sources *(left)* or for personnel work areas *(above)*.



Engineering controls for noise include mufflers *(above),* noise reducing nozzles *(right),* and vibration mounts *(below).*

- ***barriers*** between sound sources and personnel work areas;
- ***sound-absorbing material*** that reduces the overall level of noise in the workplace;
- ***mufflers*** to reduce exhaust noise;
- ***tools that produce less noise,*** such as low noise power tools and compressed air equipment;
- ***vibration mounts*** to reduce noise transmission through solid materials; and
- ***relocation of noise sources*** to more isolated areas, such as using pipe extensions to relocate pneumatic exhausts away from the immediate area and into unoccupied spaces.



A barrier (partition) between a noise source and a work area reduces personnel exposure to noise. Sound-absorbing material can also be used to further reduce exposure to noise.

Administrative controls are efforts to minimize hazards by changing behavior. Administrative controls used to reduce personnel exposures to workplace noise include

- ***signs and postings*** that alert personnel to the presence of high-noise areas before they enter;
- ***work planning*** to minimize the amount of time spent in high-noise areas;
- ***training*** to alert personnel to the hazards of exposure to high levels of occupational noise and the controls that are available to minimize exposures;
- ***maintenance*** of noise control systems, belt-driven systems, and vibration dampers to ensure proper performance and minimize unwanted sound; and
- ***quiet areas*** for work breaks and lunchrooms.

Hearing Protection Devices

HPDs serve as barriers between noise sources and your inner ear. They reduce the amount of sound reaching the inner ear but do not block sound completely; you can still hear speech, alarms, and other workplace sounds.

At or above 85 dBA (8-hour TWA)—HPDs are required!

In areas where noise is present at or above the LANL OEL of 85 dBA (8-hour TWA), you ***must*** wear hearing protection. If you work in such areas, you must be provided with HPDs. Hearing protection is also required when

- employees have not received their baseline audiometric exams for any period exceeding 6 months from the time they were first exposed to noise at or above the OEL and
- employees have incurred a standard threshold shift as determined by audiometric testing.

Types of HPDs

A variety of HPDs are available to reduce exposure to noise. Not every person can wear every HPD, and some HPDs might not work properly with other PPE or in certain working conditions. To provide for individual fit, comfort, and preference, P101-31 requires that ***workers must have a choice of at least two different HPDs*** that are suitable for the noise and working conditions. Types of HPDs include earmuffs, semi-inserts (ear canal caps), and earplugs.

Earmuffs

Earmuffs block out noise by completely covering the outer ear. Earmuffs can be "low profile," with small ear cups, or large to hold extra sound-absorbing material for use in extreme noise.

Earmuffs attached to hardhat *(above)*; earmuffs with active noise reduction and communications features *(below)*.

Advantages of earmuffs:

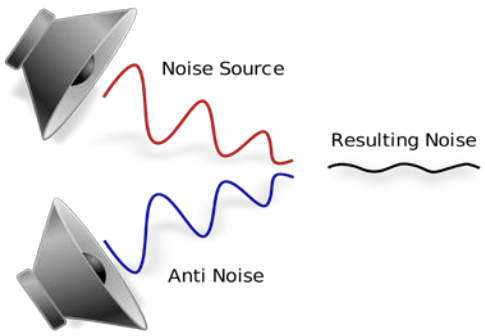
- easy to put on and adjust
- fit nearly everyone
- good for intermittent use (easy to put on and take off),
- use can be easily verified,
- may be worn with minor ear infections; and
- can be equipped with communications (radio) and/or electronic noise cancellation (active noise reduction).

The seal between the ear cups and the user's head *(above)* may be affected by eyeglass temples, face shields, respirators, or long hair.

Disadvantages of earmuffs:

- seal between the ear cups and the user's head may be affected by eyeglass temples, face shields, respirators, or long hair;
- may be too heavy for extended periods of use;
- may be uncomfortable in hot or humid work areas; and
- less portable than other devices.

Active noise reduction (ANR), available in some earmuffs, creates a noise wave that is identical to, but directly opposite of, the one coming into the ear. The "anti-noise" wave is produced by a speaker in the ear cup. When the noise wave and the anti-noise wave meet, the noise reaching the ear is reduced. ANR is good for reducing exposure to low frequencies, especially those produced by manmade machines.



Work Method Not Addressed in Job Hazard Analysis

In 2008 at the Y-12 National Security Complex, a maintenance activity was being observed when the assessor noted that a worker had obtained hearing protection (earmuffs) before using a hammer and chisel to remove a fan bearing. The assessor, who did not have hearing protection, remained outside the fan room work area. Even from outside the fan room, the sound from the hammer and chisel activity was quite loud. The assessor reviewed the job hazard analysis (JHA) and found that noise and hearing protection was not addressed.

Lessons Learned: Workers need to be aware of the hazards addressed in the JHA for the work being performed and suspend work when conditions change and/or new hazards are introduced. For hazards not addressed in the JHA, contact the supervisor and health and safety support to evaluate the new hazard and, if needed, determine the necessary controls before continuing work.

-paraphrased from Lesson ID: L-2008-OR-BWY12-1101

Semi-inserts (ear canal caps)

Semi-Inserts (Ear Canal Caps)

Semi-inserts (also called ear canal caps) are hearing protection attached to a flexible plastic or metal headband. Depending on design, the headbands can be worn over the head, behind the neck, or under the chin. In areas where noise levels often vary, earmuffs or canal caps may be preferable to earplugs because they are more easily removed.

Advantages of semi-inserts:

- good for intermittent use (easy to put on and take off);
- easy to carry around the neck when not in use; and
- use can be easily verified.

Disadvantages of semi-inserts:

- can easily lose their seal if bumped;
- the force of the caps against the ear canal entrance may be uncomfortable during extended periods of use;
- some workers find the pressure from the bands uncomfortable; and
- the tips of some semi-inserts will not adequately block all types of noise.

Earplugs

Motorcycle helmets, personal stereo headsets, swimmers' earplugs, rolled-up cotton, cigarette filters, 38-caliber shells, and hearing aids are NOT HPDs!

Earplugs are inserts made of foam or silicone that are positioned within the ear canal. Earplugs come in many styles, shapes, and noise reduction ratings (NRRs) and are easy to carry around. In addition, the protection they provide is unaffected by glasses, respirators, or long hair. However, they are not as easy to use intermittently and cannot be used effectively if the ear canal is infected or impacted with earwax. Types of earplugs include custom-molded earplugs, expandable foam earplugs, and premolded, reusable earplugs.

Custom-Molded Earplugs

Custom-molded earplugs

Custom-molded earplugs are specifically fitted to your ears. Impressions made of the inside of your ears are sent to a laboratory, where a set of custom plugs is made. Custom-molded earplugs are designed to be reused, but they must be replaced periodically because they are likely to shrink, harden, or crack over time.

NOTE: *LANL does not provide custom-molded earplugs because Occ Med has determined that they are less effective than most other types of earplugs.*

Advantages of custom-molded earplugs:

- can be fitted for specific ear canal shapes,
- are easy to store and carry; and
- are unaffected by eyeglasses, respirators, or long hair.

Disadvantages of custom-molded earplugs:

- not good for intermittent use;
- cannot be used effectively if the ear canal is infected or impacted with earwax; and
- must be replaced periodically because they can shrink, harden, or crack.

Do-it-yourself (DIY), custom-molded earplugs are now available on the internet. However, DIY custom-molded earplugs may be made of lower-quality material, and purchasers will lack the guidance of experienced, custom-ear-mold specialists. As a result, DIY custom-molded earplugs may not fit as well or block noise as well as professional lab versions. As of this writing, LANL has no written policy on the use of DIY custom-molded earplugs in the workplace.

Expandable Foam Earplugs

Expandable foam earplugs

Expandable foam earplugs are designed to expand and conform to the shape of each person's ear canal. Expandable foam earplugs are disposable and are not designed for reuse. Dirt or oils on foam earplugs can reduce their effectiveness and increase the risk of irritation of the ear canal. To avoid getting dirt or oils on your foam earplugs, ensure that your fingers are clean before inserting them.

Advantages of expandable foam earplugs:

- easy to store and carry,
- can be used with other personal protective equipment (glasses, respirators, etc.),
- convenient for use in confined work areas, and
- available in a wide variety of styles, shapes, and NRRs.

Disadvantages of expandable foam earplugs:

- not as easy to use intermittently,
- must be rolled down with clean fingers,
- must be rolled down carefully to avoid creases,
- may irritate the ear canal,
- cannot be used effectively if the ear canal is infected or impacted with earwax.
- persons with small ear canals may find it hard to roll typical plugs small enough to make them fit.

A survey of aviation personnel found that only 7% inserted earplugs deeply enough in both left and right ear canals to provide full attenuation. The far-right photo shows an earplug properly inserted to provide full attenuation.

Premolded, Reusable Earplugs

Premolded, reusable earplugs

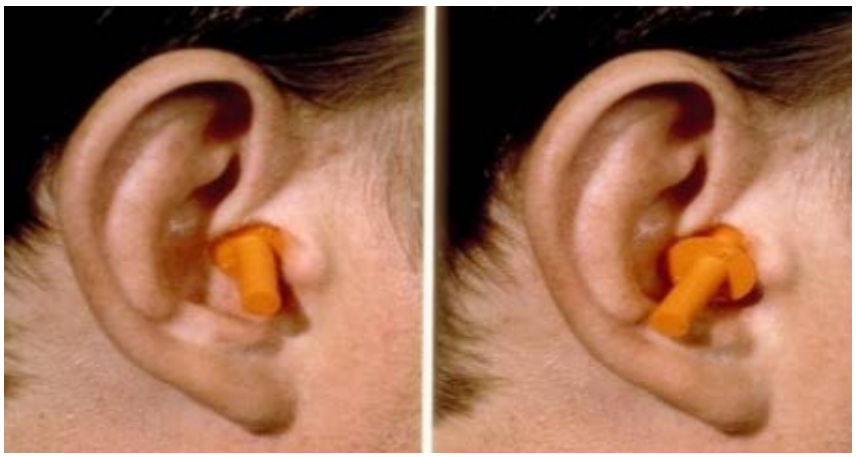
Premolded, reusable earplugs are made from silicone, plastic, or rubber and are generally available in sizes for small, medium, or large ear canals. The earplugs should seal the ear canal without being uncomfortable. In some cases, a person may need a different sized plug for each ear.

Advantages of premolded reusable earplugs:

- easy to store and carry;
- inexpensive;
- comfortable and effective for nearly everyone;
- seal is unaffected by eyeglasses, respirators, or long hair;
- can be washed and reused several times; and
- no rolling down required (in dirty or dusty environments, you do not need to handle or roll the tips with dirty fingers).

Disadvantages of premolded reusable earplugs:

- not as easy to use intermittently; and
- cannot be used effectively if the ear canal is infected or impacted with earwax.



Proper insertion of premolded reusable earplug shown on left; improper insertion shown on right.

Factors Affecting the Efficiency of HPDs

Effective hearing protection depends on

- proper fit,
- sufficient NRR, and
- continuous use.

Proper Fit

Earplugs must be carefully selected and correctly inserted if they are to provide the optimal amount of hearing protection. Earplugs that are too small will not provide sufficient protection, and those that are too large can cause discomfort.

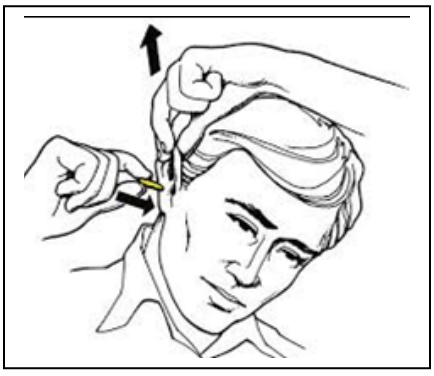
Before inserting a foam earplug, roll it into a crease-free cylinder that will easily fit into the ear canal.

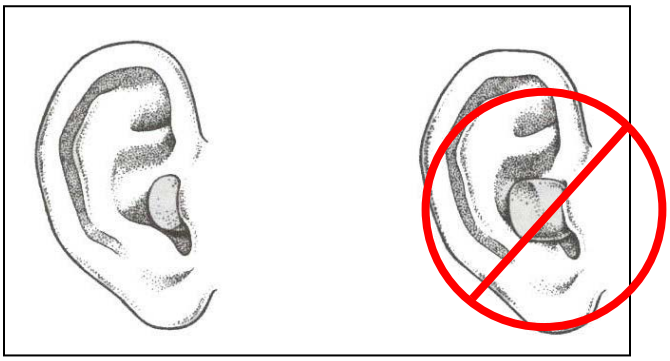
To properly insert foam earplugs, roll one plug into a crease-free cylinder that will fit easily into the ear canal. Pull back on the pinna of the ear with one hand, insert the earplug into the ear canal with the other hand, and hold your hand there for a few seconds until the earplug expands and fills the ear canal. To maintain hearing protection, try not to adjust foam earplugs that have already been inserted into your ears. Instead, remove them, re-roll them, and re-insert them.

Directions for properly inserting premolded, reusable earplugs may vary slightly, depending on the number of flanges and the shape of the tip. In general, insertion is the same as for foam earplugs, except that no rolling is required. Carefully twist the plug to break the seal for a slow, safe removal.

Check the fit of your earplugs with the **loudness test!**

To field-test the noise reduction of your earplugs, perform the **loudness test.** Press the palms of your hands (wrists forward, fingers toward the rear) over your ears while listening to a steady noise. If your earplugs fit properly, the noise level should be about the same, regardless of whether your ears are covered.

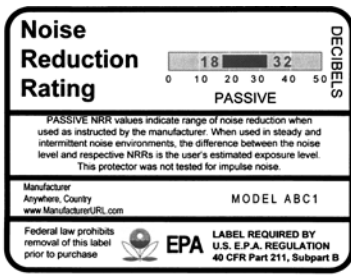


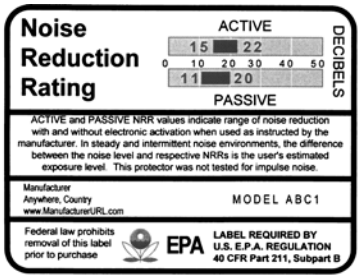


Proper insertion of foam earplugs *(left);* proper fit with foam earplugs *(right);* improper fit with foam earplugs *(far right).*

Suitable NRR

Current (above) and proposed (below) NRR labels. Notice that the lower labels show a range for the active and/or passive noise protection provided by the HPD.





Note that using plugs and muffs together does NOT let you add the NRRs of each HPD!

HPDs are rated according to the amount of noise they *attenuate*, or keep from reaching your inner ear. The amount of noise an HPD attenuates is known as the noise reduction rating (NRR). The higher the NRR, the more noise the HPD will attenuate.

The NRR is calculated in laboratory conditions and is seldom, if ever, achieved in the actual workplace. The graphs on the next page indicate real world vs experimental conditions for a selection of earplugs and earmuffs. Notice how much lower the real world attenuation is compared with the research lab attenuation.

If the NRR of an HPD is not high enough to attenuate the noise reaching your ear to a level below the OEL,

- an HPD with a higher NRR should be considered and/or
- reducing the duration of exposure should be considered.

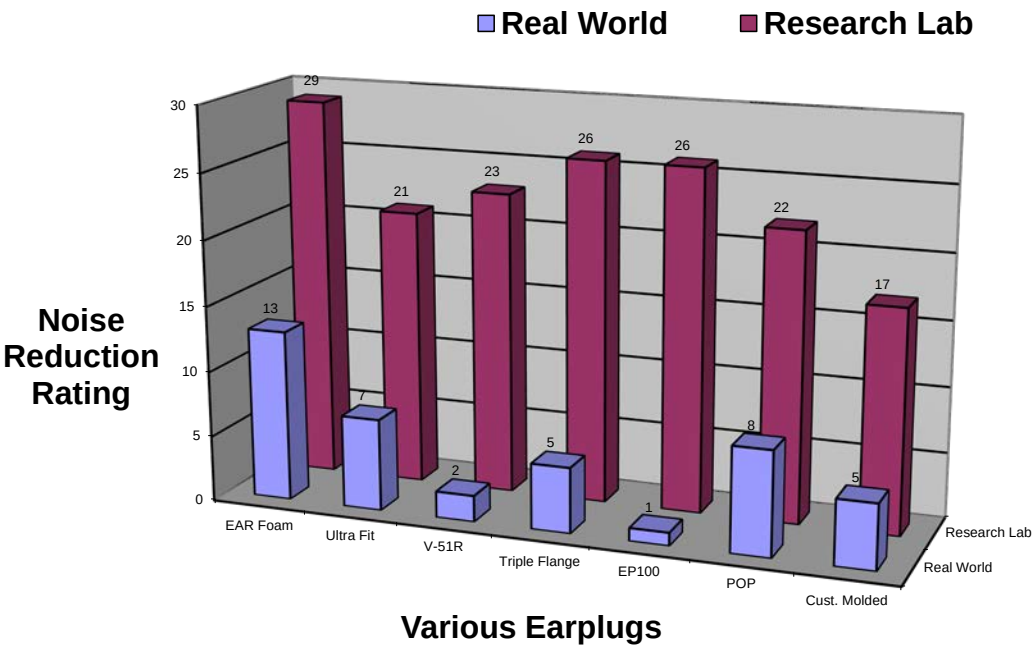
For persons who already have some hearing impairment, a lower NRR may be needed to ensure that such personnel are able to understand communications and hear alarms.

***Note:** An industrial hygienist can help you select suitable hearing protection for the noise in your workplace. If you are unsure of the type of HPD to wear, contact your area industrial hygienist.*

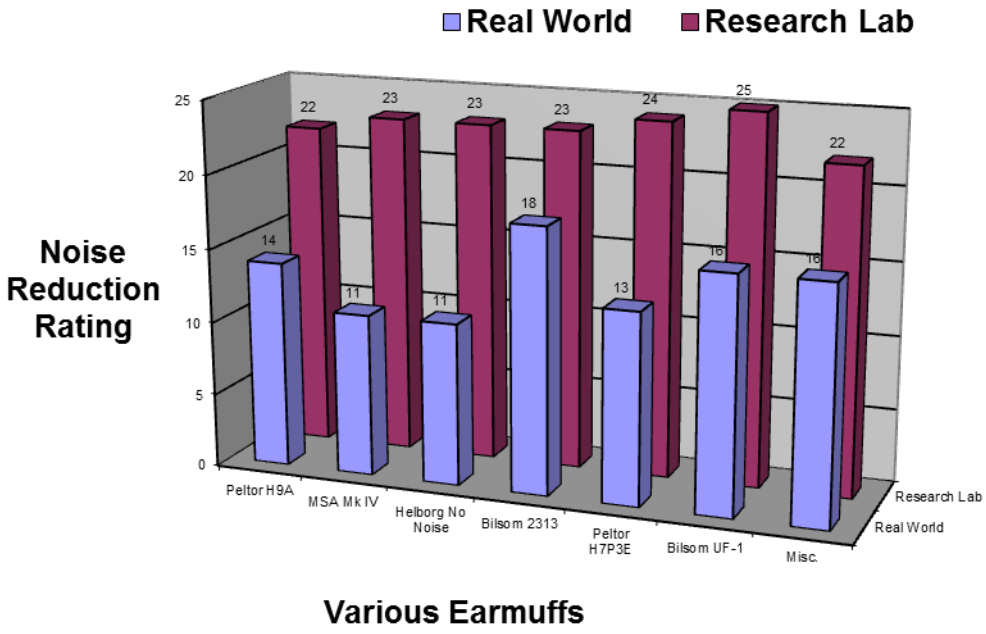
The formulas below can be used to estimate the actual noise reduction of HPDs in the workplace:

- for single protection* (***either muffs <u>or</u> plugs used***), subtract 7dB from the NRR of the HPD.
- for dual protection* (***both muffs <u>and</u> plugs used***), subtract 7dB from the NRR of the higher rated HPD and then add 5dB to account for the use of the second HPD.
- To adjust for workplace conditions, OSHA recommends applying a 50% correction factor to the NRR when estimating field attenuation.

**These formulas are modified when the NRR from the C-weighted TWA workplace noise level is known.*



Real world vs research lab noise reduction for EARPLUGS *(above)* and EARMUFFS *(below).*

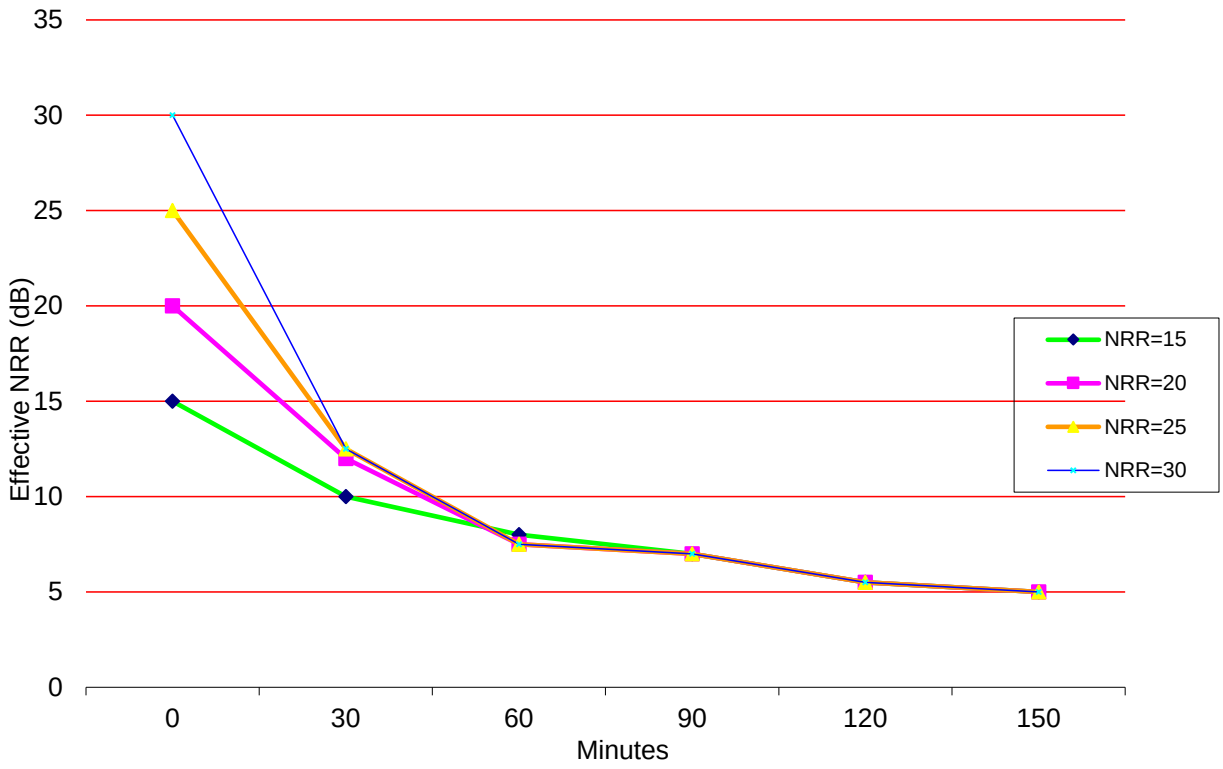


Continuous Use

When not worn continuously in noisy areas, the effectiveness of HPDs is sharply reduced. Even short periods of exposure to high noise levels during the workday will increase your risk of NIHL. The graph below shows how the NRR becomes less effective the longer an HPD is NOT worn. For example, failure to wear an HPD with an NRR rating of 25 for a period of just 30 minutes during 8 hours of exposure reduces the effective NRR by 50%.

Note: *If your work takes you to various areas with a variety of noise levels, carry a set of HPDs with you so that you will always have them if you need them!*

NRR Reduction as a Function of Number of Minutes HPD Not Worn



Caring for your HPDs

Inspect your HPDs before use and either clean or discard them as needed.

Inspect and care for your HPDs as follows:

- Before donning muffs, inspect the earcups and ear cushions for cracks, leaks, and dirt. Wash earmuffs with mild soap and water when dirty. Replace ear cushions that are no longer pliable.
- Before inserting plugs, inspect them for dirt, damage, deformation, or extreme hardness. Clean premolded and custom-molded plugs by washing them with mild soap and warm water when dirty, and then drying them before reuse. Replace premolded and custom-molded plugs that are deformed or are no longer pliable. Discard foam earplugs when dirty or at the end of each day.
- Replace earmuffs or semi-inserts when the headband is so stretched that it no longer keeps the ear cushions or plugs pressed snugly against the head.
- NEVER modify an earplug or muff to improve comfort or improve communication.
- If you use a case to store your earplugs, ensure the case is large enough to avoid bending or distorting the earplugs.
- With all HPDs, follow the instructions of the manufacturer.

PPE Substitution Leads to Noise Overexposure

Changing the personal protective equipment (PPE) identified in work activities without assessing the potential impact of such changes may result in adverse effects. In May 2009 at the Hanford Tank Waste Treatment and Immobilization Plant, a worker was performing concrete scabbling [surfacing] in the High-Level Waste Facility. Among the PPE required for the work was double hearing protection and, at a minimum, a half face respirator. Because of half-face respirator fitting issues, the worker was upgraded to a power air purifying respirator. However, double hearing protection was not compatible with the power air purifying respirator. When the respirator was changed, the potential impact to hearing protection was not considered. The worker, who wore a noise monitor during the work, exceeded the occupational exposure limit for noise.

Among the corrective actions taken, earmuffs designed to fit with a power air purifying respirator were purchased, and the job hazard analysis tool was modified to address double hearing protection when performing concrete scabbling work.

- paraphrased from Lesson ID: RPP-WTP-LL-10-0053

Actions You Can Take to Protect your Hearing

Taking personal responsibility for your hearing safety is a key factor in protecting yourself. Once you know the danger signs and accept the responsibility to protect yourself, you can take specific actions on the job and at home to conserve your hearing. Consider the following actions to protect your hearing:

- limit periods of high-noise exposure;
- lower the volume of your television, radio, headset, and other noise-producing devices;
- wear HPDs in noisy areas both on the job and at home;
- choose HPDs with an adequate NRR;
- make sure your HPDs fit properly;
- allow yourself quiet time after exposure to excessive noise;
- report high workplace noise levels to your supervisor; and
- have your hearing tested regularly.

Regardless of whether your hearing is the same as when you first started work or whether you have already lost some of your hearing, take action to preserve the hearing you have.

Worker Overexposed to Noise from Vehicle Audio System

In 2014 at the Environmental Restoration Disposal Facility for the Hanford River Corridor Closure, there were two events in which an unprotected worker was exposed to noise levels that exceeded the exposure limit. In one case, the baseline noise measurement did not account for the use of installed vehicle entertainment systems operated at high volume levels by one driver who had, but did not use, hearing aids. Recommended actions included setting expectations for worker use of in-vehicle audio systems at acceptable volume levels.

-paraphrased from Lesson ID: RCCC-2014-0006

Reporting Suspected Noise Hazards

To minimize worker exposure to excessive noise, you, along with line managers, supervisors, and all other personnel, are responsible for reporting suspected high noise areas to your area industrial hygienist or Occupational Safety and Health at 606-0295.

References

29 CFR 1910.95 {Code of Federal Regulations} *Occupational Noise Exposure* (U.S. Government Printing Office, Washington, DC.

American Conference of Governmental Industrial Hygienists (ACGIH) *2005 TLVs® and BEIs®* (Cincinnati, Ohio, 2005).

Bjorn, V. S., Albery, C. B., Shilling, R. D., U.S. Navy Flight Deck Hearing Protection Use Trends: Survey Results, NATO RTO HFM-123 Symposium Proceedings, "Directions for Improving Audio Effectiveness," Amersfoort, The Netherlands, April 2005.

Los Alamos National Laboratory Procedure (P) 101-31, *Hearing Conservation/Noise Program*.

OSHA Technical Manual, OSHA Instruction TED 01-00-015, Section III, Chapter 5, Noise, at https://www.osha.gov/dts/osta/otm/new_noise/index.html.

The Noise Manual, Fifth Edition, edited by Berger et al. (AIHA Press, 2000).

U.S. Department of Health and Human Services, Centers for Disease Control, National Institute of Occupational Safety and Health, *Occupational Noise Exposure; Revised Criteria 1998*, DHHS Publication No. 98-126 (June 1998).

U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, *Preventing Occupational Hearing Loss: A Practical Guide,* DHHS Publication No. 96-110 (October 1996).

U.S. Department of Health and Human Services, Centers for Disease Control, National Institute for Occupational Safety and Health, *Noise and Hearing Loss Prevention*, at http://www.cdc.gov/niosh/topics/noise/stats.html

Taking the Quiz

To receive credit for this self-study, you must complete the associated quiz in UTrain. You can access the quiz in either of two ways.

CRYPTOCard

If you have a CRYPTOCard that is assigned to you with administrative authorities to LANL's Integrated Computing Network (ICN):

1. Click on the link below to return to UTrain.
2. Click on the "Return to Content Structure" button.
3. Click on the "Quiz" link to begin the quiz.

To return to UTrain, click on the following link:

http://int.lanl.gov/training/tools/wrapper/submit.html

No CRYPTOCard

If you *do not* have a CRYPTOCard or if you have a CRYPTOCard *without* administrative authorities to LANL's ICN, you will need to locate a worker with UTrain proxy authority to grant you access to the quiz.

Call or email your training administrator for assistance. The following link should help you find your training administrator.

http://int.lanl.gov/services/training/admin-proctor-proxy.shtml