HEARING PROTECTION

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HEARING PROTECTION

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HEARING PROTECTION

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PREFACE

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MANUAL OBJECTIVE

The **Hearing Protection** manual presents training information and other important aspects of what you, as a Laborer, must know to protect yourself from loud and unnecessary noise on the job. It will instruct you in both technical and common-sense details of what you will encounter every day while working on the job site.

HOW TO USE THIS MANUAL

This manual introduces you to the information and work practices you need to protect your hearing on the job. Each **Section** covers a major component of the job. Concepts you will learn in each section are listed at the beginning as **Trainee Objectives**. At the end of each section, you will be expected to complete an **Assignment Sheet**.

At the back of the manual, you will find Occupational Safety and Health Administration (OSHA) regulations in the **Regulations** section. Words that may be new to you are *italicized* in the text, and those words and their definitions are found in the **Glossary**.

THANK YOU

Thank you for placing your trust in Laborers-AGC training manuals. We believe this manual will instruct you in the most significant, useful, and up-to-date technical information and safety aspects of your job.

ACKNOWLEDGEMENTS Laborers-AGC Education and Training Fund would like to thank the following organizations and companies:

- Laborers' Health and Safety Fund of North America for their time and energy in developing the material for this manual.
- Quest Technologies, Inc. for permission to use the illustration on page 2-7.
- Metrosonics for permission to use the illustration on page 2-8.
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- Aearo Company for permission to use the illustrations on pages 3-10 through 3-13.

HEARING PROTECTION

Section

1

Title

INTRODUCTION TO NOISE

TRAINEE OBJECTIVES

After completing Section 1, you will be able to:

1. Define the following terms:

   Frequency
   Noise

2. Identify what percentage of construction workers have a noise-induced hearing loss.

3. Identify what percentage of construction workers are exposed to noise at or above 85 decibels.

4. Identify the unit of measure used to measure frequency.

5. Identify the unit of measure used to measure sound pressure.

6. List the three categories of noise exposure and define each.

7. Indicate the decibel level where the threshold of pain is reached.

8. List five sources of recreational noise.

INTRODUCTION

Do you ever have trouble hearing voices in conversations or over the telephone? Is it hard to understand what is happening on television or in the movies because you missed the dialogue? Do you feel left out in a group because you cannot hear everything? If so, you probably have a hearing loss, and since you work in a noisy industry, it is probably a result of your work.

The objective of this training program is to provide you with a good understanding of:

- What noise is
- The effects of noise on hearing
- The purpose of a hearing conservation program

The manual will also discuss ways to control noise exposure through engineering and administrative controls. A review of ear plugs and ear muffs and the advantages of different types of hearing protectors will be covered.

Noise on the Job

Nobody dies from noise exposure on the job. However, noise can be both a safety and a health hazard. Construction vehicles have killed people because they could not hear back-up alarms. Noise is an important job-related health hazard in the construction industry. Hearing loss is a major problem in occupational health, at a time when other injury rates are declining.

Heavy vehicles and noisy tools are widespread on construction sites and significantly contribute to workers losing their hearing. Once hearing is lost, it can never be regained. Some studies have found that between 15 and 50 percent of construction workers have some form of noise-induced hearing loss. Studies have found that:

- Nearly 25 percent of construction workers are exposed to noise at or above 85 *decibels* (*dB*).

- Without protection, 29 percent of workers exposed to 90 dB or higher will suffer hearing loss.

- 15 percent of workers exposed to 85 dB will suffer hearing loss.

A 35-year-old Laborer, with 15 years at work, will have the hearing of a 55-year-old.

What are the effects of hearing loss on daily life? Hearing loss makes it difficult to hear telephones, enjoy movies, and most importantly, it is hard to communicate with family and friends. You may be able to hear people talking, but will be unable to understand them if you suffer from a hearing loss.

WHAT IS NOISE?

Noise, simply put, is unwanted sound. Sound is produced when an object vibrates, setting the air molecules near it into motion. The molecules travel in a sound wave that your ears receive and is channeled into the outer ear. When this wave reaches a worker's eardrum, it causes a vibration of the eardrum, and this vibration is translated by the brain into what we perceive as sound.

How is Noise Measured?

Sound travels in waves. High sounds (like an opera singer shattering a glass) create more waves per second than low sounds (like someone clearing their throat). The measurement of highness or lowness is called pitch or *frequency*. The unit of measure is cycles per second (*cps*) or *hertz* (*Hz*). Good human ears hear sounds between 20 to 20,000 Hz.

The *loudness* of sound depends upon the amount of pressure a sound wave creates. The more pressure, the louder the sound. The unit that measures sound pressure is the decibel (dB). The decibel scale is somewhat confusing because you cannot simply add or subtract decibels. Because of the extremely wide range of intensity of noises that occurs in the workplace, the decibel scale is based on a multiplication (logarithmic) scale of tens rather than an addition or subtraction scale. Table 1-1 gives examples of how loud a particular noise source is in terms of its decibel level.

Table 1-1. Common noise levels.

Noise Source	Sound Level (dBA)
Ordinary conversation	60 - 65
Busy street traffic	75 - 80
Air compressor	85 - 95
Skilsaw	89 - 104
Crane operation	90 - 96
Circular saw	102 - 106
Jackhammer	102 - 106
Pneumatic hammer	110
Abrasive blasting	115
Threshold of pain	140

There are several important rules to remember when using the decibel scale that will help you to understand the meaning of differences in decibel levels:

1. For each increase of 10 dB, the noise level (pressure) increases by ten times. For instance, 90 dB has ten times more sound pressure than 80 dB. What about comparing 90 dB with 70 dB? In this case, there is an increase of 20 dB. Because each increase of ten decibels increases the pressure by ten times, 90 dB has one hundred times (10 x 10 = 100) more sound pressure than does 70 dB. Keeping this rule in mind will help give real meaning to the difference in the decibel level of a jet engine (140 dB) and the level of normal conversation (60 dB). While the mathematical difference in these two sound levels is 80 dB (140 dB - 60 dB = 80 dB), the jet engine produces one hundred million times more sound pressure than normal conversation.

2. Every increase of 3 dB doubles the sound pressure level. This means that 93 dB has twice as much sound pressure as 90 dB. You can also turn this around. If the decibel level of a machine in a work shop has been decreased by 3 dB, then workers are exposed to one-half of the previous sound pressure. The important point of this rule is that differences of only a few decibels can mean a lot in terms of the sound pressure level of exposed workers.

3. For each increase of 10 dB, the noise will only sound twice as loud to your ears. The loudness of a sound is a descriptive term indicating how efficiently sound is translated by the brain into what we call "hearing." So, while a 10 dB increase in the noise level only sounds twice as loud to your hearing, this 10 dB increase actually represents ten times more sound pressure that is hitting your ears. Thus, workers may not be able to distinguish any differences in "loudness" between a machine that produces 93 dB compared to one producing 90 dB, even though the machine at 90 dB exposes their ears to only one-half of the sound pressure.

TYPES OF NOISE

Most noise exposures, occupational and environmental, are not constant over time. Noise exposures are classified into three categories:

1. *Continuous* - Noise that is relatively steady over long periods of time. More often found in manufacturing industries.

2. *Intermittent* - Noise that comes and goes at intervals. This type of noise exposure has large differences in noise levels throughout the day, along with periods of relative quiet. Intermittent noise may be less hazardous than continuous because your ears have a chance to rest during the quiet periods.

3. *Impact/Impulsive* - A short duration of fairly high level noise. High-level impact noise may be more hazardous to hearing than other types of noise, especially if it is combined with continuous.

Job-Related Noise

It is easy to spot noise sources in construction. Noise levels on construction sites vary, but usually range between 70 and 115 dB. At about 140 dB the threshold of pain is reached. The noise levels of tools used by Construction Craft Laborers (CCLs) are shown in Figure 1-1.

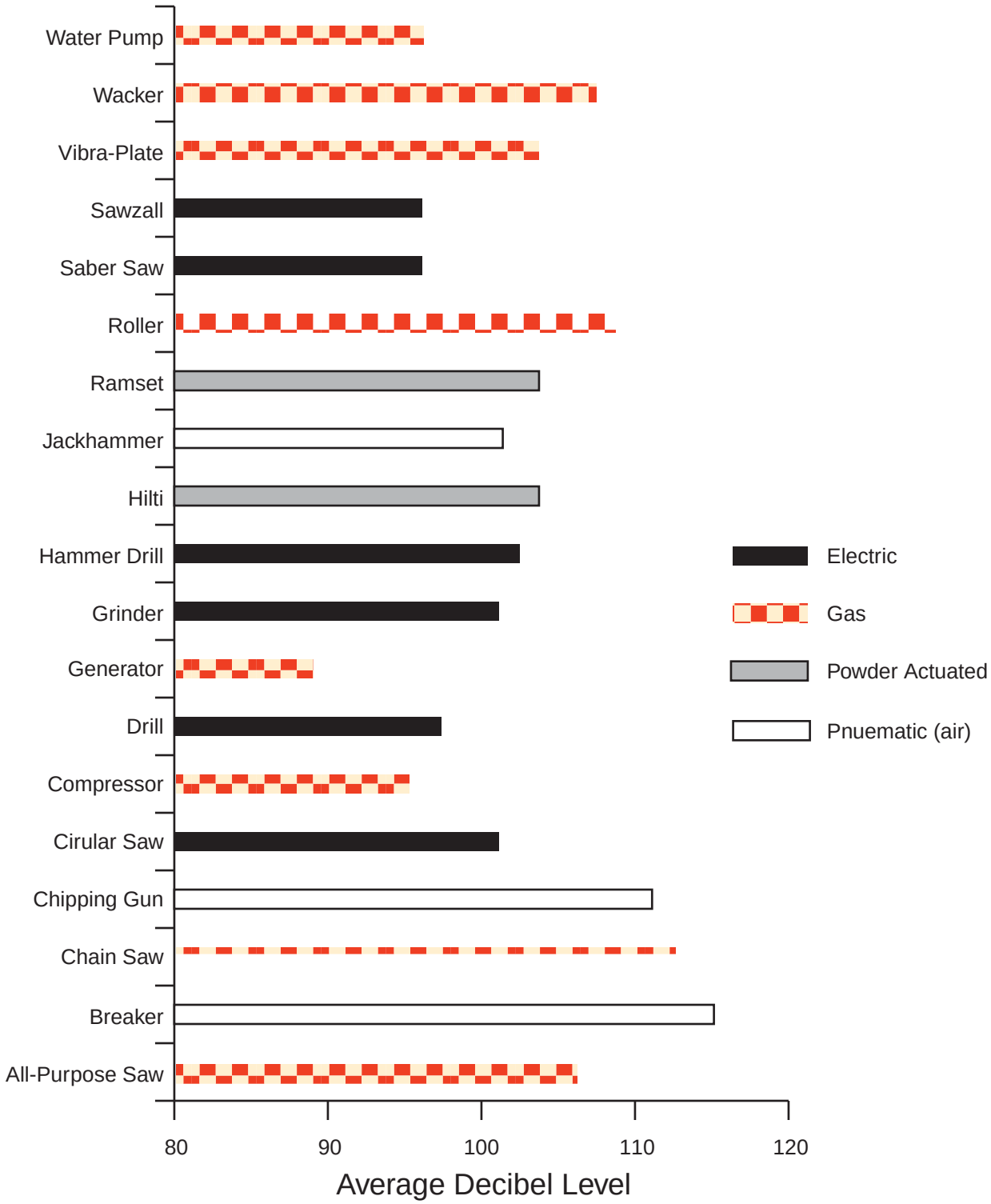

Figure 1-1. Noise levels of tools used by CCLs.

The noise is mostly produced by machinery, equipment, and hand tools. Trucks and other vehicles, such as graders, front-end loaders, and earth-moving equipment, are very loud. Cranes and pile-driving machinery, air compressors, and hand tools (e.g., pneumatic hammers, electric drills, circular saws) create noise problems.

Construction sites have a variety of sound types. Remember: continuous and impulse/impact noise sources. Air compressors are continuous, while pile-driving equipment creates enormous impact noise.

Noise levels depend on:

- The condition of the equipment - Working mufflers, proper maintenance, etc.
- The work you are doing - Working with heavier loads or against harder surfaces.
- Proximity to the source - The closer you are to the source, the louder it is.
- Combinations of noise sources - Additive effects with more than one source.
- Location - Noise inside a building will be louder than outside because of reverberation.

Off-the-Job Noise Exposure

It is important to realize that occupational noise is not the only cause of noise-induced hearing loss. There are other sources of noise exposure when away from work.

It is difficult to distinguish between job-related hearing loss and off-the-job losses. The only way for a doctor to determine the difference is to ask detailed questions about the worker's recreational activities.

Examples of recreational noise could be from motorcycles, loud music (especially stereo headphones), guns, movies, woodworking tools, etc. For example, some movies have been recorded at 110 dB.

Off-the-job noise exposures will increase the effects of work-related noise.

SECTION 1 - ASSIGNMENT SHEET

1. Define the following terms:

   Frequency _____

   _____

   Noise _____

   _____

2. Identify what percentage of construction workers have a noise-induced hearing loss.

   _____

3. Identify what percentage of construction workers are exposed to noise at or above 85 decibels.

   _____

4. Identify the unit of measure used to measure frequency.

   _____

5. Identify the unit of measure used to measure sound pressure.

   _____

6. List the three categories of noise exposure and define each.

   _____

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   _____

7. Indicate the decibel level where the threshold of pain is reached.

_____

8. List five sources of recreational noise.

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Section

2

HEARING PROTECTION

Title

HEALTH AND SAFETY

TRAINEE OBJECTIVES

After completing Section 2, you will be able to:

1. Define the following terms:

   Permissable exposure limit
   Time weighted average

2. Write out the following abbreviations or acronyms:

   DOE
   OSHA
   TTS

3. Identify the three elements that determine how noise will affect the ear.

4. Identify an early sign of temporary hearing loss or damage.

5. Identify a warning sign for permanent hearing loss.

6. List three nonaudiological effects of noise.

7. Indicate how often an area should be remeasured for noise exposure.

8. Identify the two most common instruments for measuring noise.

9. Indicate where a sound level meter is to be used to determine noise levels.

10. List the locations where noise measurements should be taken.

11. Identify who wears a dosimeter and for how long.

12. Explain the rule of thumb to determine if a noise is too loud.

INTRODUCTION

In order to understand how noise affects the ear, we need to understand how the ear functions. We also need to look at how the body is affected by noise exposure, and how to monitor and measure noise exposure. Finally, we need to be able to compare the noise exposures identified with exposure limits established by regulations.

HOW THE EAR WORKS

The ear can be divided into three parts: the outer, middle, and inner ear (Figure 2-1). Each of these parts plays a different role in transmitting sound to the brain.

Figure 2-1. The human ear has three parts.

The outer ear collects sound waves and causes the eardrum to vibrate. The middle ear has three small bones (the hammer, anvil, and stirrup) connected to the eardrum. As your eardrum vibrates, these bones vibrate, too. The bones transmit their vibrations to the inner ear where they end up at a special snail-shaped structure called the cochlea. The cochlea is a rolled-up, tapered canal that is filled with fluid. The vibrations cause the fluid in the cochlea to vibrate (bend back and forth). This in turn causes tiny hair cells in your ear to vibrate. When the hair cells bend (vibrate), it is converted into an electrical impulse by the auditory nerve. The impulses travel along nerves to the brain, where they are translated into the sensation of hearing or sound.

The hair cells respond to noise vibrations in two basic ways:

1. Only certain hair cells bend to any particular frequency of sound. Thus, hair cells respond only to the *frequency* to which they are sensitive.

2. The amount of bending the hairs undergo depends on how much energy (*decibels*) the noise has—the greater the energy, the more bending that takes place (i.e., the louder the noise will sound).

HEALTH EFFECTS

How noise affects you will depend upon how long you were exposed to a sound, the *loudness* of the sound, and the ability of your body to recover after that exposure.

Temporary Threshold Shift

Temporary threshold shift (*TTS*) is a temporary loss of hearing. If you are exposed to a very noisy job, by the end of the shift you may have noticed a loss of hearing sensitivity. For instance, if you left your car radio on as you parked after work, you may find that the radio is blaring the next morning. This may be an early sign of hearing damage or loss. Such losses may occur after only a few minutes of exposure to intense noise. The greatest portion of temporary *hearing loss* occurs within the first two hours of exposure.

The hair cells in your inner ear become exhausted from the excessive noise exposure and require more energy (decibels) before they will bend and send nerve impulses to the brain. This effect is “temporary” because the hair cells get a chance to rest while you are away from work, and by the next morning, they have recovered their sensitivity. Recovery usually begins within one or two hours after being removed from the exposure. Full recovery from a TTS occurs within about 14 hours.

Permanent Threshold Shift

Permanent threshold shift is a permanent hearing loss that is very similar to the pattern of temporary hearing loss, except that you do not recover.

Some of the hair cells have been physically destroyed by the constant pounding and bending, leading to nerve loss. You now have fewer hair cells to respond to the

sound at the frequency where the loss has taken place. The more exposure to loud noise, the more hair cells are destroyed. This eventually leads to total deafness. Permanent loss does not respond to any known treatment or cure.

Long term exposure to loud noise may result in a hearing loss that involves the speech frequency range—approximately 500 to 5,000 *hertz* (*Hz*). It can affect a person's ability to communicate. Healthy human ears hear frequencies between 20 and 20,000 Hz. However, the ear is more sensitive to sound in the frequency range of 4,000 to 6,000 Hz. Noise-induced hearing loss occurs in this range first.

The ability to comprehend speech becomes impaired, especially with high frequency sounds like "s," "f," and "th." For example, workers may have trouble distinguishing between the words "fifteen" and "sixteen."

Recognizing that you are suffering from a permanent loss is difficult because the process is usually gradual and may not be noticeable in the beginning. Not all workers are affected equally by exposure to the same noise level, so your co-workers may not mention that they cannot seem to hear as well as they once did.

Tinnitus

Tinnitus is a ringing in the ears, similar to high-pitched background squealing with TVs and computers. It may accompany temporary and permanent hearing loss. Tinnitus is most noticeable in quiet conditions (e.g., sleeping at night) and may be a warning signal of permanent hearing loss.

Non-Auditory Effects

Noise can affect more than just your hearing. First of all, the psychological effects of noise-induced hearing loss can be devastating. Noise can be a major cause of stress, adding to nervousness and anxiety. Noise may increase the heart rate and raise blood pressure by constricting blood vessels. Studies have shown that noise exposure can produce a permanent increase in blood pressure leading to heart disease.

The stress of noise places the body in a constant state of "alert." This can lead to ulcers and other digestive problems, increased cholesterol levels in the blood, disturbed sleep, and elevated tension levels.

Presbycusis

Presbycusis is a hearing loss as a result of aging. Its onset and the amount of damage vary among people. It usually begins around age 50. Some people may never have hearing loss from presbycusis. Family/genetic factors influence the extent of the loss. Presbycusis can be accelerated by noise exposure.

MONITORING NOISE EXPOSURE

As with any health hazard, it is extremely important to determine the extent of the noise or hearing hazard and to identify affected employees. Initial monitoring of the work site or noisy tasks should be done to identify employees overexposed to noise.

Noise exposures should be remeasured periodically to make sure that they have not changed. Changes in equipment, work processes, or schedules could make workers' exposures higher or lower. In addition, workers' noise exposures must be analyzed to find out which type of hearing protectors or controls should be used. For example, an employee that has an exposure level of 98 *decibels* (*dB*) will need hearing protectors that provide more protection than an employee with an exposure level of 90 dB.

The most common instruments for measuring noise are the sound level meter and the dosimeter.

Sound Level Meter

A *sound level meter* (*SLM*) is an instrument used to determine noise levels at a specific location (i.e., a piece of equipment) at a specific moment (Figure 2-2). These instruments will help identify work areas where employees' exposures may be above hazardous levels, and where more thorough exposure monitoring may be needed.

Figure 2-2. The Quest 2500 sound level meter. (Image courtesy of Quest Technologies, Inc.)

Rather than require hearing protection use for all workers at all times, the SLM is used to identify only those times when hearing protection is needed. For example, a quick check of sound levels from a noisy piece of equipment might prove that hearing protection is required only when a worker is operating that specific piece of equipment. Other workers may not need to wear it.

Typical measurement locations could include:

- The hearing zone at an employee's normal work location.
- Next to the noise source(s).
- At the entrance(s) to the work area.
- At other locations within the work area where the employee might spend time working.

SLMs are *A-weighted* to determine exposure levels. This means they filter out some low and very high frequency sounds to measure the way the human ear hears. Noise exposure levels that are A-weighted are abbreviated *dBA*.

Dosimeter

A *dosimeter* is used to get work-day exposure information (Figure 2-3). The dosimeter is worn by a worker, usually for a full eight-hour shift. It provides an average exposure level for the entire workday. Dosimeters are better than SLMs at estimating a worker's entire-day exposure.

Figure 2-3. Metrosonics db-3080 noise monitor. (Image courtesy of Metrosonics)

Dosimeters are especially effective if a worker performs a variety of jobs or moves around to several different work areas during the workday and is exposed to many different noise levels.

The dosimeter records the worker's exposure level and then compares it to the permissible exposure limit. For the Occupational Safety and Health Administration (*OSHA*), it is 90 dBA. For the Department of Energy (*DOE*), this limit is 85 dBA. For example, if a worker

wore a dosimeter for eight hours and the readout was 100 percent, the worker was exposed to an average of 90 dB for the workday.

These instruments must be carefully checked and calibrated to ensure the measurements are accurate. Calibration procedures are unique to specific instruments and manufacturers.

EXPOSURE LIMITS

An important concept involved with noise exposure is the *time-weighted average* (*TWA*) exposure level. TWA simply means your exposure levels are averaged over an 8-hour workday. Usually, noise exposures fluctuate (high and low) during the day, so the time spent at different noise levels is added and then averaged to get the TWA. The TWA usually is calculated automatically by using a noise dosimeter. The TWA is then compared against the *permissible exposure limit* (*PEL*) established by OSHA.

PEL is the legal exposure limit that you can be exposed to without the use of controls or personal protective equipment. It is calculated as 8-hour TWA. Table 2-1 lists the OSHA PELs for noise. Some states and other organizations have their own, more protective noise standards. For example, DOE has adopted a more restrictive PEL of 85 dBA versus OSHA's 90 dBA.

Table 2-1. OSHA and DOE permissible exposure limits for noise.

Duration per day (Hours)	OSHA Limits (dBA)	DOE Limits (dBA)
8	90.0	85.0
6	92.0	86.5
4	95.0	88.0
3	97.0	89.5
2	100.0	91.0
$1\frac{1}{2}$	102.0	92.5
1	105.0	94.0
$\frac{1}{2}$	110.0	97.0
$\frac{1}{4}$	115.0	100.0

A good rule of thumb to determine if a noise is too loud is the 3-foot rule. If you are standing 3 feet from someone and must shout to be heard, the noise level is probably over the OSHA *action level* and DOE exposure limit.

OSHA has established an action level when workers are approaching the PEL. When a worker is exposed to 85 dBA, the employer must administer an effective hearing conservation program. When your exposure reaches 85 dBA, your employer must control the noise exposure or provide you with hearing protection.

Exchange Rates

Exchange rates are a relationship between the PEL and exposure time. For example, the DOE has a 3 dB exchange rate, which means that the noise exposure level may be raised by 3 dB, but only if the exposure time is cut in half. So you can be exposed to 88 dB for 4 hours and 91 dB for 2 hours without some hearing protection. Remember, sound intensity (damage) doubles every 3 dB. The remaining workday time must be spent in a quiet area where exposure is below the PEL. OSHA has a less protective 5 dB exchange rate. The 3 dB rule more accurately reflects how sound works.

SECTION 2 - ASSIGNMENT SHEET

1. Define the following terms:

   Permissible exposure limit _____

   _____

   Time weighted average _____

   _____

2. Write out the following abbreviations or acronyms:

   DOE _____

   OSHA _____

   TTS _____

3. Identify the three elements that determine how noise will affect the ear.

   _____

   _____

   _____

4. Identify an early sign of temporary hearing loss or damage.

   _____

   _____

5. Identify a warning sign for permanent hearing loss.

   _____

6. List three nonaudiological effects of noise.

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7. Indicate how often an area should be remeasured for noise exposure.

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8. Identify the two most common instruments for measuring noise.

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9. Indicate where a sound level meter is to be used to determine noise levels.

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10. List the locations where noise measurements should be taken.

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11. Identify who wears a dosimeter and for how long.

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12. Explain the rule of thumb to determine if a noise is too loud.

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Section

3

HEARING PROTECTION

Title

HEARING CONSERVATION PROGRAM

TRAINEE OBJECTIVES

After completing Section 3, you will be able to:

1. Write out the following acronyms:

   HCP
   NRR

2. Define the following term:

   Attenuation

3. Identify at what noise level an employer is required to administer a hearing conservation program.

4. Identify the noise exposure level that triggers the necessity for an annual hearing test.

5. Explain why a baseline audiogram is taken.

6. State the length of time you should be away from workplace noise before receiving a baseline audiogram.

7. List the three ways to control noise exposure and identify which ones must be considered first.

8. State the advantage of using engineering controls.

9. State at what exposure level workers must be provided hearing protection.

10. Identify the exposure level that no one should ever be exposed to without hearing protection.

11. Determine the attenuation of a disposable ear plug (NRR = 29) if the noise exposure level is 105 dBA.

12. Indicate when disposable ear plugs should be replaced.

INTRODUCTION

The Occupational Safety and Health Administration (*OSHA*) and the Department of Energy (*DOE*) regulations require employers to establish a Hearing Conservation Program (*HCP*) when employee exposures are 85 *dBA* or higher. An HCP consists of monitoring noise levels and notifying employees about results, conducting hearing tests, training employees, and providing hearing protection. The following is a discussion of the components of the HCP.

NOISE EXPOSURES

Noise exposures are measured to determine which employees should be included in the HCP. As stated earlier, employees exposed to 85 dBA or more are included in the program according to OSHA and DOE regulations.

AUDIOMETRIC TESTING

Audiometric tests, also known as *audiograms,* are simply hearing tests to evaluate the effects of noise on your ears. If you are exposed to 85 dBA or higher, you must have your hearing tested annually.

Audiograms do not save hearing, but attempt to identify any small losses (if any) and make corrections (e.g., more hearing protection) before the losses become permanent or handicapping.

The tests must be given by an *audiologist* in a quiet room or booth. Testing takes only 5 to 10 minutes per person. There are two types of audiograms required for HCPs: baseline and annual.

Baseline Audiogram

The *baseline audiogram* is the reference audiogram against which future hearing tests are compared. It is a permanent record of your hearing when you began the job and can be compared with later tests to determine how much hearing you have lost over the years.

Baseline audiograms must be provided within six months of an employee's first exposure at or above an 8-hour *time weighted average* (*TWA*) of 85 dBA.

Employees should not be exposed to workplace noise for 14 hours before the baseline test. Tests could be done prior to work, preferably on a Monday after a weekend of rest away from occupational exposure. However, appropriate hearing protectors can serve as a substitute for the 14-hour requirement. It is the employer's responsibility to notify employees to avoid, if possible, high noise exposures for the 14 hours before the test.

Annual Audiogram

Annual audiograms must be given within one year of the baseline and at least once per year, thereafter. If employees are exposed to higher noise levels (> 100 dB), then employers may want to give audiograms every six months.

Annual audiograms are compared to baseline audiograms to determine if the employee has lost any hearing ability. If a hearing loss has been found, protective follow-up measures can be made before the loss progresses too far.

Unlike the baseline audiograms, annual audiograms can be taken at any time during the workshift. In fact, it is best to take them at the end of the workshift. Taking the test during/after work could help identify any temporary hearing loss (temporary threshold shift) created by job-related noise. These temporary hearing losses can be a sign of more permanent losses in the future.

An annual audiogram may be substituted for the baseline audiogram if it is determined that hearing improves. This will ensure that the baseline reflects a worker's best possible hearing.

Audiogram Analysis

When comparing the annual audiograms to the baseline test, the audiologist tries to find a hearing loss—also known as a *standard threshold shift* (*STS*). According to OSHA, an STS is an average shift in hearing of 10 dB or more at 2,000, 3,000, and 4,000 *hertz* (*Hz*) in either ear.

The sample audiogram shows a worker whose hearing was damaged by noise (Figure 3-1). The numbers at the bottom of the graph represent the various frequencies that were tested. The numbers on the side of the graph represent the dB level that was required before the worker first heard the sound. The upper line is taken

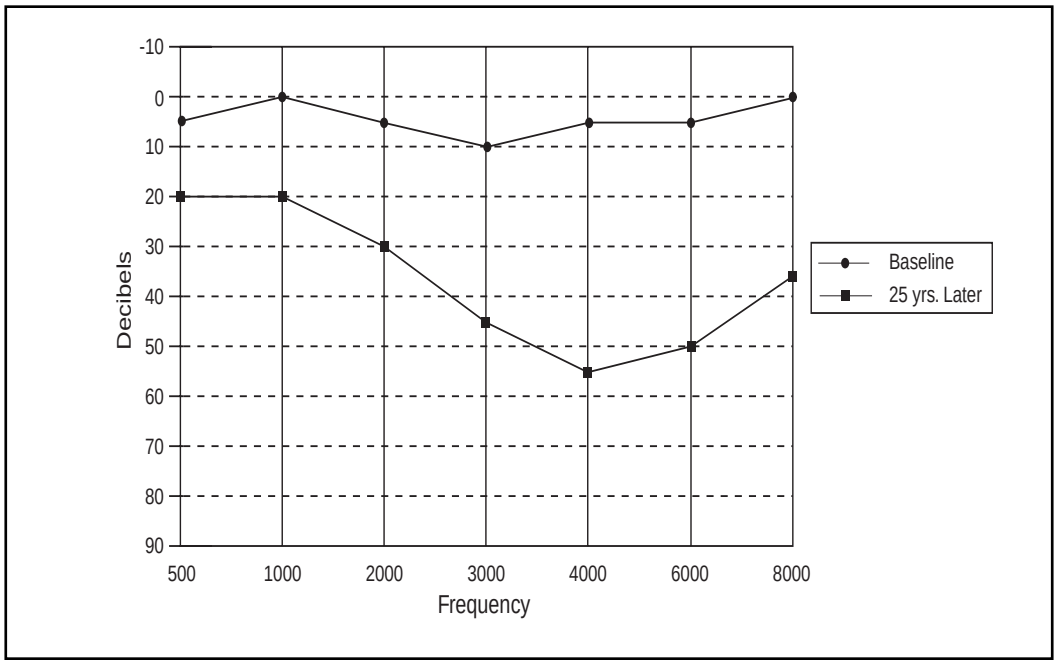

Figure 3-1. This sample audiogram shows a standard threshold shift.

from the pre-employment or baseline audiogram. The lower line is the result after 25 years of exposure to a noisy job. So, in this audiogram, the 25-year line shows more dBs were required for the worker to hear the noise. The worker has an STS.

Employees must receive a written notification (and explanation of the results) within 21 days of the test if an STS has occurred. A worker has 30 days to get a second opinion if an STS is identified.

If an STS is identified and employees:

- Do not use hearing protectors, they must be fitted with them, trained on their use and care, and required to wear them.

- Already use hearing protectors, he or she must be fitted with protectors that offer more protection.

An average hearing loss of 25 dB is a recordable injury (OSHA 200 log) and may be compensable (depending on state workers' compensation laws).

RECORDKEEPING

Accurate records are important for comparing annual audiograms with the baseline audiogram. Comparing audiogram records is the only way to determine if a hearing loss has occurred. Records of all audiograms must be kept in the worker's medical file for the length of employment.

The audiogram records must include all audiometric test results, the employee's name and job title, date of the audiogram, the examiner's name, the calibration date of the audiometer, the worker's most recent exposure assessment, and background noise levels in the test room.

Noise exposure records must be kept for at least two years. This includes area noise surveys with the sound level meters and personal sampling using the dosimeters. Workers, or their representatives, must be allowed to see these records upon request.

Other records that may be useful to keep are:

- Hearing protector records - type of protector used, including the make, model, and size.

- Training records - date and type of training provided, who provided it, and who attended it. Since Construction Craft Laborers change jobs frequently, it may be useful to keep a copy of your own records for comparison from year to year.

CONTROLLING NOISE EXPOSURE

When workers are exposed to noise levels that are 85 dBA or higher, their employer is required to take some form of corrective action to reduce their exposure.

There are three ways to control noise exposure:

1. *Engineering controls*
2. *Administrative control*s
3. Hearing protectors

Administrative or engineering controls must be considered first, but if they are not feasible then personal protective equipment must be provided.

Engineering Controls

Engineering controls are the best solution to preventing noise-induced hearing loss. Engineering controls are a modification or replacement of equipment or physical change to machinery that reduces the noise level to the employee's ear. The advantage of using of engineering controls is they eliminate the noise hazard.

Typical engineering controls include:

- Reducing noise at the source - installing a muffler.
- Interrupting the noise path - setting up acoustical barriers, such as cabs on heavy equipment.
- Reducing reverberation - installing sound absorbing material.

Routine maintenance of machines can help lower noise levels. For instance, replacing worn gears with tight gears, balancing rotating parts, or frequent lubrication will not only extend the life of a machine, but will also reduce noise levels as well.

Many types of previously noisy equipment are now made in noise-controlled versions. Companies should have "buy quiet" programs to purchase quieter construction equipment.

Administrative Controls

Administrative controls reduce the worker's exposure time to noise by:

- Moving away from the source. Merely moving away from a noise source can significantly reduce exposure. Sound in the open air can be reduced by about 6 dB for each doubling of the distance away from the source. For example, if 90 dB at 5 feet, then at 10 feet it would be 84 dB.
- Changing job schedules. If a noisy operation is performed for one 8-hour day per week, it might be possible to change to two 4-hour days per week to achieve a reduction in daily noise exposure.

- Rotating workers. Transfer workers from a noisy job to a job with lower noise levels so that the worker's daily noise exposure is within the permissible limits. For example, two workers could split an 8-hour shift of exposure to 88 dB, so that each worker would have 4 hours in the noisy environment and 4 hours in a quiet area. Rotating employees between quiet and noisy jobs—while reducing the substantial risk of hearing loss to a few—may increase the risk of small hearing loss in many workers.

- Operate noisy machinery during times when fewer workers will be exposed.

- Provide quiet areas where employees can rest their ears when on break.

Administrative controls tend to disrupt established work practices and schedules. While administrative controls do have some merit, they should be viewed as a temporary solution to the noise problem.

Hearing Protectors

Workers who are exposed to noise at or above 85 dBA for an 8-hour TWA must be provided hearing protection if engineering or administrative controls fail to reduce the noise exposure below 85 dBA. Workers covered by the OSHA General Industry Standard (29 *CFR* 1910.95) and the OSHA Construction Standard (29 CFR 1926.52) are required to wear hearing protection when noise exposure reaches an 8-hour TWA of 90 dBA or higher. DOE workers are required to wear hearing protection when noise exposure reaches an 8-hour TWA of 85 dBA or higher.

Higher noise levels for shorter periods of time also require hearing protection. The type of hearing protection required would depend on the noise exposure.

For really high exposures, it may be useful to use muffs and plugs. That should be determined from your exposure levels by the industrial hygienist. Do **not** "over protect," because that may block out important warning signals.

No one should ever be exposed to more than 115 dBA without hearing protection. Remember, as a rough gauge, if you have to raise your voice to talk to people standing three feet away, the noise level is probably above 85 dBA.

The individual worker should have a choice from a variety of suitable protectors (for fit and comfort), including both ear plugs and muffs. If a hearing protector does not fit right, it will not protect a worker's hearing. Hearing protectors must be made available at the employer's expense.

The purpose of hearing protectors is to reduce the amount of sound transmitted to the middle and inner ear. The number of decibels or amount of sound reduced by the protector is called *attenuation*. All plugs or muffs will have an attenuation or *noise reduction rating* (*NRR*) listed in decibels for each model. The right hearing protection, correctly worn, can reduce noise levels by 20 to 30 dB (E-A-R® yellow foam plugs have an NRR of 29 dB). That is often a crucial difference for your ears.

A simple formula is used to tell you how many decibels are reaching your middle and inner ear through the protector:

$$\text{Decibels} - \frac{(\text{NRR} - 7)}{2} = \text{Attenuation}$$

For example, the plugs you are using have an NRR of 29 dB, and you are exposed to 95 dBA of noise on the job. When wearing the protectors, your ears are exposed to 84 dBA:

$$95 \text{ dBA} - \frac{(29 - 7)}{2} = 95 \text{ dBA} - (11) = 84 \text{ dBA}$$

However, a protector, when worn in the field, usually does not provide the amount of attenuation listed by the NRR. This may be from not wearing it properly or from it being the wrong size. Also, attenuation may lessen as protectors become older.

Attenuation must reduce exposure to your ears to below 90 dBA, and preferably to below 85 dBA. Also, whenever there is a change in working conditions, your hearing protectors must be reevaluated to make sure they provide enough protection to reduce sound levels below 90 dBA. If workplace noise levels increase, workers must be given more effective protectors.

Disposable Ear Plugs

Formable or disposable ear plugs are made of expandable foam and usually come in one size. These are the most popular ear plugs and those most commonly found on the job site (Figure 3-2).

Disposable ear plugs roll up and fit inside the ear canal and then expand to form a seal. They furnish good hearing protection when properly inserted, so make sure to follow the manufacturer's directions. Also, clean your hands before inserting the plugs because dirt and germs can be transferred from your hand to the plugs and cause ear infections. Replace disposable plugs as soon as they become damaged or dirty.

Reusable Ear Plugs

Reusable plugs are pre-formed to fit the ear (Figure 3-3). They usually are made of flexible rubber or silicon and can be flanged or cone shaped. Some are joined by a cord so they are not easily lost; others may be on a headband. The headband ensures uniform pressure on your ears.

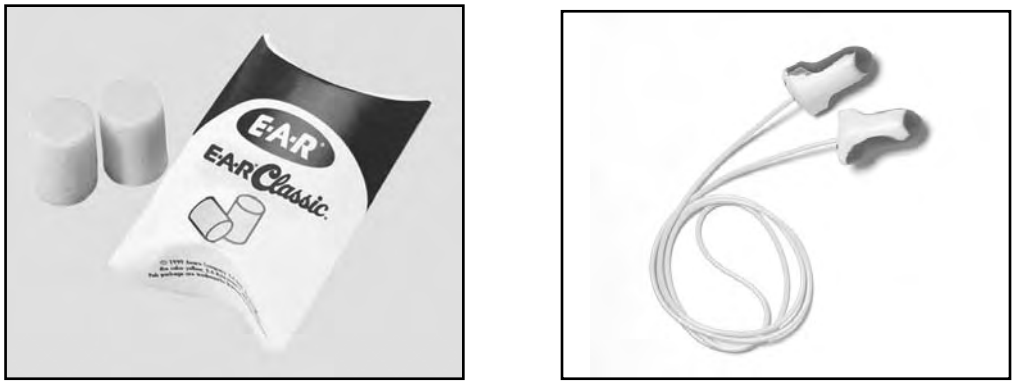

Figure 3-2. Two examples of disposable ear plugs include E-A-R® Classic (left) and Howard Leight LL30 (right).

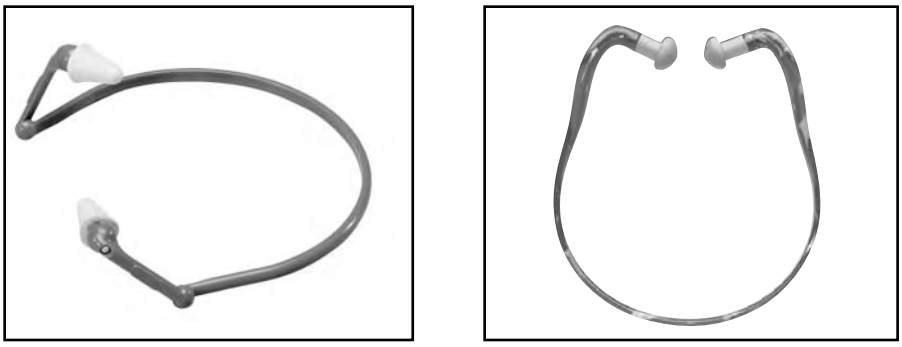

Figure 3-3. Two examples of reusable ear plugs are the E-A-R® Flexband reusable ear plugs (left) and Howard Leight's QB3^{HYG} reusable ear plugs (right).

Be sure to use plugs that are the right size for your ears. If you need help to determine this, ask your supervisor. While pre-molded plugs are reusable, they can deteriorate and should be replaced periodically.

Reusable ear plugs should be washed in lukewarm water using hand soap, rinsed with clean water, and dried before using. Wet or damp plugs should not be placed in their containers when storing.

Custom-Molded Ear Plugs

Custom-molded plugs are made for individual employees from a mold of the worker's ear. Although they are more expensive, workers are more likely to wear them because they are more comfortable.

Inserting Foam Ear Plugs

Before inserting a foam ear plug, compress the ear plug as tightly as you can. Roll the plug between your fingertips (Figure 3-4) or use the thumbs and forefingers of both hands (Figure 3-5). Compression is important because the diameter of the ear plug must be smaller than the diameter of the ear canal to insert it (Figure 3-6).

It is best to insert a plug by pulling up and outward on the outer ear with the opposite hand. Put the left hand around the top the head and pull up and out on the right ear (Figure 3-7).

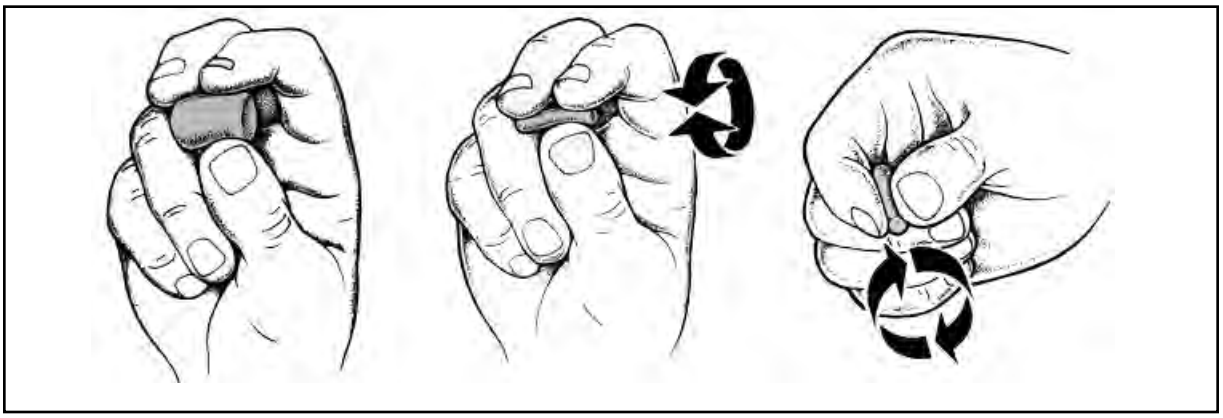

Figure 3-4. To compress the ear plug, roll the plug between your fingertips and thumb.

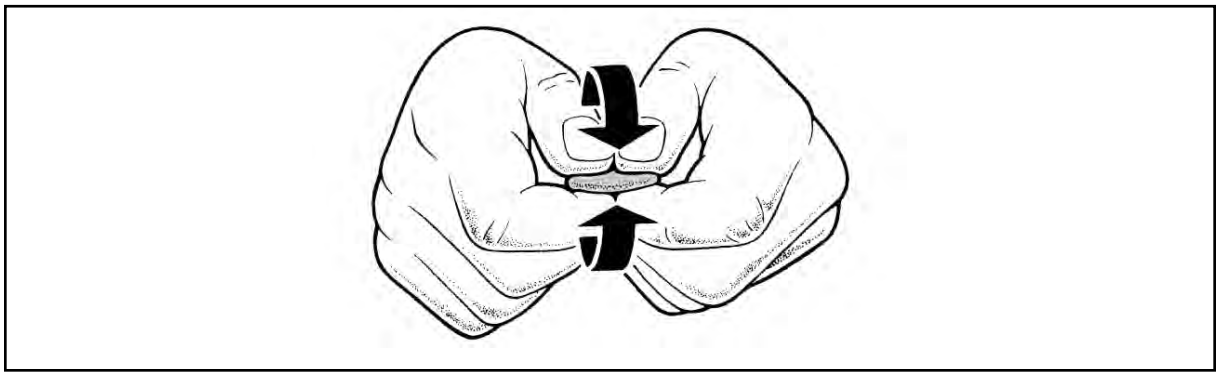

Figure 3-5. You can also compress the ear plug by using the thumbs and forefingers of both hands.

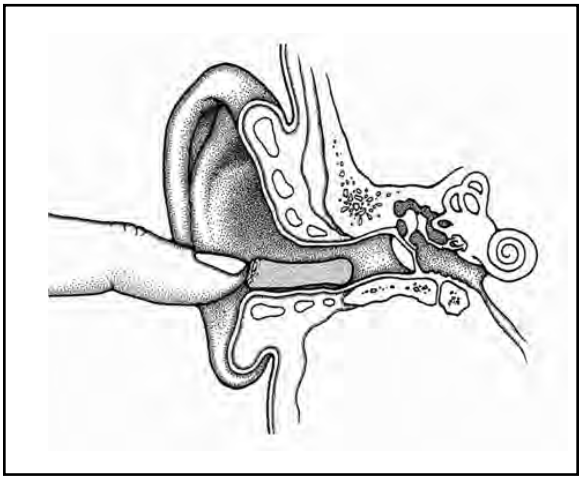

Figure 3-6. To insert the ear plug, the diameter of the ear plug must be smaller than the diameter of the ear canal

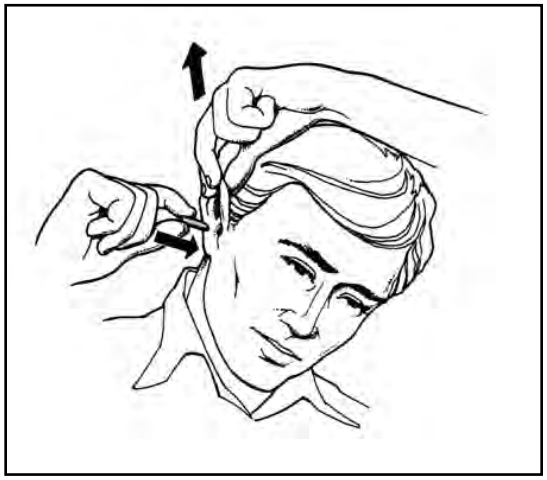

Figure 3-7. Pull up and outward on the outer ear with the opposite hand. Put your left hand around the top the head and pull up and out on the right ear.

Ear Muffs

Ear muffs for construction look like stereo headphones (Figure 3-8). They have soft plastic cushions that are filled with foam or liquid. These cushions provide a seal around the entire ear.

To be effective, the ear muff seal must not be interrupted. Wearing a respirator, a hard hat, or eyeglasses, or having longer hair, can prevent a good seal. As a result, you may need to wear another type of hearing protector.

Attenuation is less likely to vary with ear muffs than with ear plugs. Ear muffs have better attenuation at lower frequencies than most plugs.

Some newer ear muffs use electronic circuitry to allow communication. This is done by allowing low and moderate level sound in while attenuating noise over 85 or 90 dB.

Ear muffs are heavier and hotter to wear than ear plugs. They come in one size, although different brands may be smaller or larger than others. The headband pressure of ear muffs can become uncomfortable if worn for long periods.

Figure 3-8. The examples of ear muffs are the E-A-R's Model 100 (left) and Howard Leight® Model LM-7H (right).

Ear muffs and plugs can be worn together for extra protection if noise is high enough (>105 dB). Attenuation will not be doubled, but will increase by about 5 to 10 dB.

Care and Maintenance

Proper care and maintenance of ear muffs will ensure their effectiveness and extend their life span.

- Replace ear muffs if the cushions become stiff, worn, cut, or torn.
- Do **not** modify the muffs in any way.
- Keep ear muff cushions clean. Clean the plastic or foam cushions in the same way as ear plugs.
- Do **not** get the inside of the muff wet.
- Store ear muffs in the open air to allow any moisture in the cups to evaporate.

BARRIERS TO HEARING CONSERVATION PLANS

Hearing protection is important to our health, safety, and quality of life. However some barriers can hinder a Hearing Conservation Plan from being followed:

- Nobody dies from a hearing loss. It is not as dramatic as falling off a scaffold or having a trench collapse. But you could be killed if you cannot hear warning signals.
- Hearing loss is a gradual process that takes years to develop and then it is too late.
- Workers are constantly changing employers, so it is hard to maintain records.
- OSHA rarely enforces hearing conservation requirements.

- Many workers do not like to wear hearing protection because:
  - Hearing protectors are uncomfortable. Workers need a variety of hearing protectors to choose from, and they need to be taught how to wear them correctly.
  - They may miss warning signals. Construction sites are noisy, and workers do not want to miss back-up alarms, etc. (Solutions: do not over-attenuate so workers hear signals. Use quieter equipment.)
  - Workers are used to the noise.
  - Many workers already have significant hearing loss.

SECTION 3 - ASSIGNMENT SHEET

1. Write out the following acronyms:

   HCP _____

   NRR _____

2. Define the following term:

   Attenuation _____

   _____

3. Identify at what noise level an employer is required to administer a hearing conservation program.

   _____

4. Identify the noise exposure level that triggers the necessity for an annual hearing test.

   _____

5. Explain why a baseline audiogram is taken.

   _____

   _____

   _____

6. State the length of time workers should be away from workplace noise before a baseline audiogram.

   _____

7. List the three ways to control noise exposure and identify which ones must be considered first.

   _____

   _____

   _____

8. State the advantage of using engineering controls.

_____

_____

9. State at what exposure level workers must be provided hearing protection.

_____

_____

10. Identify the exposure level that no one should ever be exposed to without hearing protection.

_____

_____

11. Determine the attenuation of a disposable ear plug (NRR = 29) if the noise exposure level is 105 dBA.

_____

_____

12. Indicate when disposable ear plugs should be replaced.

_____

_____

Section

Regulations

HEARING PROTECTION

Title

29 CFR 1910.95

§ 29 CFR 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:

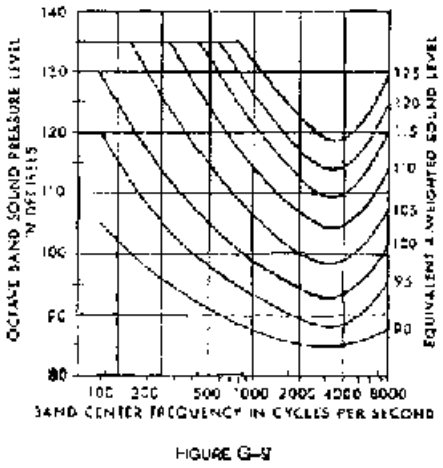

FIGURE G-9

FIGURE G-9 - Equivalent A-Weighted Sound Level

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 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.

TABLE G-16 - PERMISSIBLE NOISE EXPOSURES (1)

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

Footnote (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) C(n)/T(n) exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn 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.

(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.

(3) 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, or who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and properly using, maintaining and checking calibration and proper functioning of the audiometers being used. A technician who operates microprocessor audiometers does not need to be certified. A technician who performs audiometric tests must be responsible to an audiologist, otolaryngologist or physician.

(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.

(ii) “Mobile test van exception.” Where mobile test vans are used to meet the audiometric testing obligation, the employer shall obtain a valid baseline audiogram within 1 year of an employee's first exposure at or above the action level. Where baseline audiograms are obtained more than 6 months after the employee's first exposure at or above the action level, employees shall wearing hearing protectors for any period exceeding six months after first exposure until the baseline audiogram is obtained.

(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.

(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.

(ii) In determining whether a standard threshold shift has occurred, allowance may be made for the contribution of aging (presbycusis) to the change in hearing level by correcting the annual audiogram according to the procedure described in Appendix F: "Calculation and Application of Age Correction to Audiograms."

(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 microprocessor audiometers) that meet the specifications of, and are maintained and used in accordance with, American National Standard Specification for Audiometers, S3.6-1969, which is incorporated by reference as specified in Sec. 1910.6.

(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:

(A) Has not yet had a baseline audiogram established pursuant to paragraph (g)(5)(ii); or

(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

(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.

(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.

(o) Exemptions.

Paragraphs (c) through (n) of this section shall not apply to employers engaged in oil and gas well drilling and servicing operations.

(p) Startup date.

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

[39 FR 23502, June 27, 1974, as amended at 46 FR 4161, Jan. 16, 1981; 46 FR 62845, Dec. 29, 1981; 48 FR 9776, Mar. 8, 1983; 48 FR 29687, June 28, 1983; 54 FR 24333, June 7, 1989; 61 FR 5507, Feb. 13, 1996; 61 FR 9227, March 7, 1996]

APPENDIX A
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:

$$D = 100\,(C(1)/T(1) + C(2)/T(2) + \ldots + C(n)/T(n)),$$

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.

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
129	0.036
130	0.031

In the above table the reference duration, T, is computed by

$$T = \frac{8}{2^{(L-90)/5}}$$

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.

TABLE A-1
CONVERSION FROM "PERCENT NOISE EXPOSURE"OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)

Dose or percent noise exposure	TWA
10	73.4
15	76.3
20	78.4
25	80.0
30	81.3
35	82.4
40	83.4
45	84.2
50	85.0
55	85.7
60	86.3
65	86.9
70	87.4
75	87.9
80	88.4
81	88.5
82	88.6
83	88.7
84	88.7
85	88.8
86	88.9
87	89.0
88	89.1
89	89.2
90	89.2
91	89.3
92	89.4
93	89.5
94	89.6
95	89.6
96	89.7
97	89.8
98	89.9
99	89.9
100	90.0
101	90.1
102	90.1
103	90.2
104	90.3
105	90.4
106	90.4
107	90.5
108	90.6
109	90.6
110	90.7
111	90.8
112	90.8
113	90.9
114	90.9
115	91.1
116	91.1
117	91.1
118	91.2
119	91.3
120	91.3
125	91.6
130	91.9
135	92.2
140	92.4
145	92.7
150	92.9
155	93.2
160	93.4
165	93.6
170	93.8
175	94.0
180	94.2

TABLE A-1 (continued)
CONVERSION FROM "PERCENT NOISE EXPOSURE"OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)

Dose or percent noise exposure	TWA
185	94.4
190	94.6
195	94.8
200	95.0
210	95.4
220	95.7
230	96.0
240	96.3
250	96.6
260	96.9
270	97.2
280	97.4
290	97.7
300	97.9
310	98.2
320	98.4
330	98.6
340	98.8
350	99.0
360	99.2
370	99.4
380	99.6
390	99.8
400	100.0
410	100.2
420	100.4
430	100.5
440	100.7
450	100.8
460	101.0
470	101.2
480	101.3
490	101.5
500	101.6
510	101.8
520	101.9
530	102.0
540	102.2
550	102.3
560	102.4
570	102.6
580	102.7
590	102.8
600	102.9
610	103.0
620	103.2
630	103.3
640	103.4
650	103.5
660	103.6
670	03.7
680	103.8
690	103.9
700	104.0
710	104.1
720	104.2
730	104.3
740	104.4
750	104.5
760	104.6
770	104.7
780	104.8
790	104.9
800	105.0
810	105.1
820	105.2
830	105.3
840	105.4
850	105.4
860	105.5
870	105.6
880	105.7
890	105.8
900	105.8
910	105.9
920	106.0
930	106.1
940	106.2
950	106.2
960	106.3
970	106.4
980	106.5
990	106.5
999	106.6

Appendix 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 No. 1, No. 2 and No. 3. The NRR described below is a simplification of NIOSH method No. 2. The most complex method is NIOSH method No. 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-weighing 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.

Appendix C
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 (+ or - 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 + or - 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

Appendix D
Audiometric Test Rooms

This Appendix is mandatory.

Rooms used for audiometric testing shall not have background sound pressure levels exceeding those in Table D-1 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 - 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

Appendix E
Acoustic Calibration of Audiometers

This Appendix is Mandatory.

Audiometer calibration shall be checked acoustically, at least annually, according to the procedures described in this appendix. The equipment necessary to perform these measurements is a sound level meter, octave-band filter set, and a National Bureau of Standards 9A coupler. In making these measurements, the accuracy of the calibrating equipment shall be sufficient to determine that the audiometer is within the tolerances permitted by American Standard Specification for Audiometers, S3.6-1969.

(1) "Sound Pressure Output Check"

A. Place the earphone coupler over the microphone of the sound level meter and place the earphone on the coupler.

B. Set the audiometer's hearing threshold level (HTL) dial to 70 dB.

C. Measure the sound pressure level of the tones at each test frequency from 500 Hz through 6000 Hz for each earphone.

D. At each frequency the readout on the sound level meter should correspond to the levels in Table E-1 or Table E-2, as appropriate, for the type of earphone, in the column entitled "sound level meter reading."

(2) "Linearity Check"

A. With the earphone in place, set the frequency to 1000 Hz and the HTL dial on the audiometer to 70 dB.

B. Measure the sound levels in the coupler at each 10-dB decrement from 70 dB to 10 dB, noting the sound level meter reading at each setting.

C. For each 10-dB decrement on the audiometer the sound level meter should indicate a corresponding 10 dB decrease.

D. This measurement may be made electrically with a voltmeter connected to the earphone terminals.

(3) "Tolerances"

When any of the measured sound levels deviate from the levels in Table E-1 or Table E-2 by + or - 3 dB at any test frequency between 500 and 3000 Hz, 4 dB at 4000 Hz, or 5 dB at 6000 Hz, an exhaustive calibration is advised. An exhaustive calibration is required if the deviations are greater than 15 dB or greater at any test frequency.

TABLE E-1 - REFERENCE THRESHOLD LEVELS FOR TELEPHONICS - TDH-39 EARPHONES

Frequency, Hz	Reference Threshold Level for TDH-49 Earphones, dB	Sound Level Meter Reading, dB
500	11.5	81.5
1000	7.0	77.0
2000	9.0	79.0
3000	10.0	80.0
4000	9.5	79.5
6000	15.5	85.5

TABLE E-2 - REFERENCE THRESHOLD LEVELS FOR TELEPHONICS - TDH-49 EARPHONES

Frequency Hz	Reference threshold level for TDH 49 earphones dB	level meter reading,dB
500	13.5	83.5
1000	7.5	77.5
2000	11.0	81.0
3000	9.5	79.5
4000	10.5	80.5
6000	13.5	83.5

Appendix F
Calculations and Application of Age Corrections to Audiograms

This Appendix Is Non-Mandatory

In determining whether a standard threshold shift has occurred, allowance may be made for the contribution of aging to the change in hearing level by adjusting the most recent audiogram. If the employer chooses to adjust the audiogram, the employer shall follow the procedure described below. This procedure and the age correction tables were developed by the National Institute for Occupational Safety and Health in the criteria document entitled "Criteria for a Recommended Standard . . . Occupational Exposure to Noise," ((HSM)-11001).

For each audiometric test frequency;

(i) Determine from Tables F-1 or F-2 the age correction values for the employee by:

(A) Finding the age at which the most recent audiogram was taken and recording the corresponding values of age corrections at 1000 Hz through 6000 Hz;

(B) Finding the age at which the baseline audiogram was taken and recording the corresponding values of age corrections at 1000 Hz through 6000 Hz.

(ii) Subtract the values found in step (i)(B) from the value found in step (i)(A).

(iii) The differences calculated in step (ii) represented that portion of the change in hearing that may be due to aging.

EXAMPLE: Employee is a 32-year-old male. The audiometric history for his right ear is shown in decibels below.

	Audiometric test frequency (Hz)				
Employee's Age	1000	2000	3000	4000	6000
26	10	5	5	10	5
*27	0	0	0	5	5
28	0	0	0	10	5
29	5	0	5	15	5
30	0	5	10	20	10
31	5	10	20	15	15
*32	5	10	10	25	20

The audiogram at age 27 is considered the baseline since it shows the best hearing threshold levels. Asterisks have been used to identify the baseline and most recent audiogram. A threshold shift of 20 dB exists at 4000 Hz between the audiograms taken at ages 27 and 32.
(The threshold shift is computed by subtracting the hearing threshold at age 27, which was 5, from the hearing threshold at age 32, which is 25). A retest audiogram has confirmed this shift.
The contribution of aging to this change in hearing may be estimated in the following manner:
Go to Table F-1 and find the age correction values (in dB) for 4000 Hz at age 27 and age 32.

	Frequency (Hz)				
	1000	2000	3000	4000	6000
Age 32	6	5	7	10	14
Age 27	5	4	6	7	11
Difference	1	1	1	3	3

The difference represents the amount of hearing loss that may be attributed to aging in the time period between the baseline audiogram and the most recent audiogram. In this example, the difference at 4000 Hz is 3 dB. This value is subtracted from the hearing level at 4000 Hz, which in the most recent audiogram is 25, yielding 22 after adjustment. Then the hearing threshold in the baseline audiogram at 4000 Hz (5) is subtracted from the adjusted annual audiogram hearing threshold at 4000 Hz (22). Thus the age-corrected threshold shift would be 17 dB (as opposed to a threshold shift of 20 dB without age correction).

TABLE F-1
AGE CORRECTION VALUES
IN DECIBELS FOR MALES

Years	Audiometric Test Frequency (Hz)				
	1000	2000	3000	4000	6000
20 or younger	5	3	4	5	8
21	5	3	4	5	8
22	5	3	4	5	8
23	5	3	4	6	9
24	5	3	5	6	9
25	5	3	5	7	10
26	5	4	5	7	10
27	5	4	6	7	11
28	6	4	6	8	11
29	6	4	6	8	12
30	6	4	6	9	12
31	6	4	7	9	13
32	6	5	7	10	14
33	6	5	7	10	14
34	6	5	8	11	15
35	7	5	8	11	15
36	7	5	9	12	16
37	7	6	9	12	17
38	7	6	9	13	17
39	7	6	10	14	18
40	7	6	10	14	19
41	7	6	10	14	20
42	8	7	11	16	20
43	8	7	12	16	21
44	8	7	12	17	22
45	8	7	13	18	23
46	8	8	13	19	24
47	8	8	14	19	24
48	9	8	14	20	25
49	9	9	15	21	26
50	9	9	16	22	27
51	9	9	16	23	28
52	9	10	17	24	29
53	9	10	18	25	30
54	10	10	18	26	31
55	10	11	19	27	32
56	10	11	20	28	34
57	10	11	21	29	35
58	10	12	22	31	36
59	11	12	22	32	37
60 or older	11	13	23	33	38

TABLE F-2
AGE CORRECTION VALUES IN DECIBELS FOR FEMALES

Years	Audiometric Test Frequency (Hz)				
	1000	2000	3000	4000	6000
20 or younger	7	4	3	3	6
21	7	4	4	3	6
22	7	4	4	4	6
23	7	5	4	4	7
24	7	5	4	4	7
25	8	5	4	4	7
26	8	5	5	4	8
27	8	5	5	5	8
28	8	5	5	5	8
29	8	5	5	5	9
30	8	6	5	5	9
31	8	6	6	5	9
32	9	6	6	6	10
33	9	6	6	6	10
34	9	6	6	6	10
35	9	6	7	7	11
36	9	7	7	7	11
37	9	7	7	7	12
38	10	7	7	7	12
39	10	7	8	8	12
40	10	7	8	8	13
41	10	8	8	8	13
42	10	8	9	9	13
43	11	8	9	9	14
44	11	8	9	9	14
45	11	8	10	10	15
46	11	9	10	10	15
47	11	9	10	11	16
48	12	9	11	11	16
49	12	9	11	11	16
50	12	10	11	12	17
51	12	10	12	12	17
52	12	10	12	13	18
53	13	10	13	13	18
54	13	11	13	14	19
55	13	11	14	14	19
56	13	11	14	15	20
57	13	11	15	15	20
58	14	12	15	16	21
59	14	12	16	16	21
60 or older	14	12	16	17	22

Appendix G
Monitoring Noise Levels

Non-mandatory Informational Appendix

This appendix provides information to help employers comply with the noise monitoring obligations that are part of the hearing conservation amendment.

WHAT IS THE PURPOSE OF NOISE MONITORING?

This revised amendment requires that employees be placed in a hearing conservation program if they are exposed to average noise levels of 85 dB or greater during an 8 hour workday. In order to determine if exposures are at or above this level, it may be necessary to measure or monitor the actual noise levels in the workplace and to estimate the noise exposure or "dose" received by employees during the workday.

WHEN IS IT NECESSARY TO IMPLEMENT A NOISE MONITORING PROGRAM?

It is not necessary for every employer to measure workplace noise. Noise monitoring or measuring must be conducted only when exposures are at or above 85 dB. Factors which suggest that noise exposures in the workplace may be at this level include employee complaints about the loudness of noise, indications that employees are losing their hearing, or noisy conditions which make normal conversation difficult. The employer should also consider any information available regarding noise emitted from specific machines. In addition, actual workplace noise measurements can suggest whether or not a monitoring program should be initiated.

HOW IS NOISE MEASURED?

Basically, there are two different instruments to measure noise exposures: the sound level meter and the dosimeter. A sound level meter is a device that measures the intensity of sound at a given moment. Since sound level meters provide a measure of sound intensity at only one point in time, it is generally necessary to take a number of measurements at different times during the day to estimate noise exposure over a workday. If noise levels fluctuate, the amount of time noise remains at each of the various measured levels must be determined.

To estimate employee noise exposures with a sound level meter it is also generally necessary to take several measurements at different locations within the workplace. After appropriate sound level meter readings are obtained, people sometimes draw "maps" of the sound levels within different areas of the workplace. By using a sound level "map" and information on employee locations throughout the day, estimates of individual exposure levels can be developed. This measurement method is generally referred to as "area" noise monitoring.

A dosimeter is like a sound level meter except that it stores sound level measurements and integrates these measurements over time, providing an average noise exposure reading for a given period of time, such as an 8-hour workday. With a dosimeter, a microphone is attached to the employee's clothing and the exposure measurement is simply read at the end of the desired time period. A reader may be used to read-out the dosimeter's measurements. Since the dosimeter is worn by the employee, it measures noise levels in those locations in which the employee travels. A sound level meter can also be positioned within the immediate vicinity of the exposed worker to obtain an individual exposure estimate. Such procedures are generally referred to as "personal" noise monitoring.

Area monitoring can be used to estimate noise exposure when the noise levels are relatively constant and employees are not mobile. In workplaces where employees move about in different areas or where the noise intensity tends to fluctuate over time, noise exposure is generally more accurately estimated by the personal monitoring approach.

In situations where personal monitoring is appropriate, proper positioning of the microphone is necessary to obtain accurate measurements. With a dosimeter, the microphone is generally located on the shoulder and remains in that position for the entire workday. With a sound level meter, the microphone is stationed near the employee's head, and the instrument is usually held by an individual who follows the employee as he or she moves about.

Manufacturer's instructions, contained in dosimeter and sound level meter operating manuals, should be followed for calibration and maintenance. To ensure accurate results, it is considered good professional practice to calibrate instruments before and after each use.

HOW OFTEN IS IT NECESSARY TO MONITOR NOISE LEVELS?

The amendment requires that when there are significant changes in machinery or production processes that may result in increased noise levels, remonitoring must be conducted to determine whether additional employees need to be included in the hearing conservation program. Many companies choose to remonitor periodically (once every year or two) to ensure that all exposed employees are included in their hearing conservation programs.

WHERE CAN EQUIPMENT AND TECHNICAL ADVICE BE OBTAINED?

Noise monitoring equipment may be either purchased or rented. Sound level meters cost about $500 to $1,000, while dosimeters range in price from about $750 to $1,500. Smaller companies may find it more economical to rent equipment rather than to purchase it. Names of equipment suppliers may be found in the telephone book (Yellow Pages) under headings such as: "Safety Equipment," "Industrial Hygiene," or "Engineers-Acoustical." In addition to providing information on obtaining noise monitoring equipment, many companies and individuals included under such listings can provide professional advice on how to conduct a valid noise monitoring program. Some audiological testing firms and industrial hygiene firms also provide noise monitoring services. Universities with audiology, industrial hygiene, or acoustical engineering departments may also provide information or may be able to help employers meet their obligations under this amendment.

Free, on-site assistance may be obtained from OSHA-supported state and private consultation organizations. These safety and health consultative entities generally give priority to the needs of small businesses.

Appendix H
Availability of Referenced Documents

Paragraphs (c) through (o) of 29 CFR 1910.95 and the accompanying appendices contain provisions which incorporate publications by reference. Generally, the publications provide criteria for instruments to be used in monitoring and audiometric testing. These criteria are intended to be mandatory when so indicated in

the applicable paragraphs of 1910.95 and appendices.

It should be noted that OSHA does not require that employers purchase a copy of the referenced publications. Employers, however, may desire to obtain a copy of the referenced publications for their own information.

The designation of the paragraph of the standard in which the referenced publications appear, the titles of the publications, and the availability of the publications are as follows:

Paragraph designation	Referenced publication	Available from
Appendix B	"List of Personal Hearing Protectors and Attenuation Data," HEW Pub. No. 76-120, 975. NTIS-PB267461	National Technical Information Service, Port Royal Road, Springfield, VA 22161.
Appendix D	"Specification for Sound Level Meters," S1.4-1971 (R1976).	American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.
1910.95(k)(2), Appendix E	"Specifications for Audiometers," S3.6-1969.	American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.
Appendix D	"Specification for Octave, Half-Octave and Third-Octave Band Filter Sets," S1.11-1971 (R1976).	Back Numbers Department, Dept. STD, American Institute of Physics, 333 E. 45th St., New York, NY 10017; American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

The referenced publications (or a microfiche of the publications) are available for review at many universities and public libraries throughout the country. These publications may also be examined at the OSHA Technical Data Center, Room N2439, United States Department of Labor, 200 Constitution Avenue, NW., Washington, DC 20210, (202) 219-7500 or at any OSHA Regional Office (see telephone directories under United States Government - Labor Department).

Appendix I
Definitions

These definitions apply to the following terms as used in paragraphs (c) through (n) of 29 CFR 1910.95.

Action level - An 8-hour time-weighted average of 85 decibels measured on the A-scale, slow response, or equivalently, a dose of fifty percent.**Audiogram** - A chart, graph, or table resulting from an audiometric test showing an individual's hearing threshold levels as a function of frequency.
Audiologist - A professional, specializing in the study and rehabilitation of hearing, who is certified by the American Speech-Language-Hearing Association or licensed by a state board of examiners.
Baseline audiogram - The audiogram against which future audiograms are compared.
Criterion sound level - A sound level of 90 decibels.
Decibel (dB) - Unit of measurement of sound level.
Hertz (Hz) - Unit of measurement of frequency, numerically equal to cycles per second.
Medical pathology - A disorder or disease. For purposes of this regulation, a condition or disease affecting the ear, which should be treated by a physician specialist.
Noise dose - The ratio, expressed as a percentage, of (1) the time integral, over a stated time or event, of the 0.6 power of the measured SLOW exponential time-averaged, squared A-weighted sound pressure and (2) the product of the criterion duration (8 hours) and the 0.6 power of the squared sound pressure corresponding to the criterion sound level (90 dB).
Noise dosimeter - An instrument that integrates a function of sound pressure over a period of time in such a manner that it directly indicates a noise dose.
Otolaryngologist - A physician specializing in diagnosis and treatment of disorders of the ear, nose and throat.
Representative exposure - Measurements of an employee's noise dose or 8-hour time-weighted average sound level that the employers deem to be representative of the exposures of other employees in the workplace.

Sound level - Ten times the common logarithm of the ratio of the square of the measured A-weighted sound pressure to the square of the standard reference pressure of 20 micropascals. Unit: decibels (dB). For use with this regulation, SLOW time response, in accordance with ANSI S1.4-1971 (R1976), is required.
Sound level meter - An instrument for the measurement of sound level.
Time-weighted average sound level - That sound level, which if constant over an 8-hour exposure, would result in the same noise dose as is measured.

Section

GLOSSARY

HEARING PROTECTION

Title

A

A-weighted - A measurement scale that approximates the "loudness" of tones relative to a reference tone.

Action level - An 8-hour time-weighted average of 85 decibels measured on the A-scale, slow response, or equivalently, a dose of 50 percent.

Administrative controls - Exposure control measures that reduce exposure to an acceptable limit by scheduling reduced work times in contaminated areas and establishing work rules.

Attenuation - Estimated sound protection provided by hearing protection devices as worn in "real-world" environments.

Audiogram - Graph of hearing threshold level as a function of frequency.

Audiologist - A professional, specializing in the study and rehabilitation of hearing, who is certified by the American Speech-Language Hearing Association or licensed by a state board of examiners.

B

Baseline audiogram - A valid audiogram against which subsequent audiograms are compared to determine if hearing thresholds have changed.

C

CFR - Code of Federal Regulations

Continuous noise - Noise of a constant level measured over at least one second using the "slow" setting on a sound level meter.

cps - Cycles per second

D

dB - Decibels

dBA - Decibel A-weighted

Decibel - Unit used to express intensity of sound.

DOE - Department of Energy

Dosimeter - An instrument that measures sound levels over a specified interval, stores the measures, and calculates the sound as a function of sound level and sound duration and describes the results in terms of dose, time-weighted average and (perhaps) other parameters such as peak level, equivalent sound level, etc.

E

Engineering controls - Any mechanical device, physical barrier, enclosure, or other design procedure that reduces the sound level at the source of noise generation or along the path of propagation of the noise to the individual. This does not include protective equipment such as earmuffs, plugs, or administrative controls.

Exchange rate - The relationship between intensity and dose. OSHA uses a 5-dB exchange rate. DOE uses a 3-dB exchange rate.

F

Frequency - The number of waves, vibrations, or cycles that pass any given point in a certain period of time, usually one second expressed in hertz. When related to hearing, it is the measurement of high and low sounds.

G

No Entries

H

HCP - Hearing Conservation Plan

Hearing loss - Hearing loss is often characterized by the area of the auditory system responsible for the loss.

Hz - Hertz

Hertz - The unit measurement for audio frequency, numerically equal to cycles per second.

I

Impulsive or impact noise - Used to generally characterize impact or impulse noise which is typified by a sound which rapidly rises to a sharp peak and then quickly fades. The sound may or may not have a "ringing" quality (such as a striking a hammer on a metal plate or a gunshot in a reverberant room). Impulsive noise be repetitive, or may be a single event (as with a sonic boom). Note: if impulses occur in very rapid succession (such as with some jack hammers), the noise would not be described as impulsive.

Intermittent noise - Variations in noise levels that involve peaks of intensity that occur at intervals of greater than one second. If the noise peaks occur at intervals of one second or less, the noise is considered continuous.

L

Loudness - The subjective attribute of a sound by which it would be characterized along a continuum from “soft” to “loud.”

LIUNA - Laborers’ International Union of North America

M

No Entries

N

Noise - Any unwanted sound.

NRR - Noise reduction rating

Noise reduction rating - The NRR is a single-number rating method that attempts to describe a hearing protector based on how much the overall noise level is reduced by the hearing protector.

O

OSHA - Occupational Safety and Health Administration

P

PEL - Permissible exposure limit

Permanent threshold shift - Permanent increase in the threshold of audibility for an ear.

Permissible exposure limit - An OSHA standard designating the maximum occupational exposure permitted as an 8-hour time-weighted average.

Personal protective equipment - Any protective clothing or device used to prevent contact with and exposure to physical, chemical, or biological hazards in the workplace.

Presbycusis - The gradual increase in hearing loss that is attributable to the effects of aging, and not related to medical causes or noise exposure.

Q–R

No Entries

S

SLM - Sound level meter

Sound level meter - A device that measures sound and provides a readout of the resulting measurement.

Sound pressure level - The term used to identify a sound measurement (expressed in decibels) obtained with a sound level meter that has a flat frequency response.

Standard threshold shift - Term used by OSHA to describe 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. Used by OSHA to trigger additional audiometric testing and related followup.

STS - Standard threshold shift

T

Temporary threshold shift - Temporary increase in the threshold of audibility for an ear caused by exposure to high-intensity acoustic stimuli.

Time weighted average - A value, expressed in dBA, which is computed so that the resulting average would be equivalent to an exposure resulting from a constant noise level over an 8-hour period.

Tinnitus - sensation of a ringing, roaring, or buzzing sound in the ears or head. It is often associated with many forms of hearing impairment and noise exposure.

TTS - Temporary threshold shift

TWA - Time weighted average

U–Z

No Entries