

**HARVARD UNIVERSITY**  
**HEARING CONSERVATION PROGRAM**



Prepared by Environmental Health & Safety

## **Table of Contents**

- I. Introduction
- II. Monitoring
- III. Sampling Methods
- IV. Exposure Control
- V. Hearing Protection Devices
- VI. Noise Placards
- VII. Training
- VIII. Audiometric Testing
- IX. Standard Threshold Shift
- X. Record Keeping
  
- Appendix A Occupational Noise Standard 29 CFR 1910.95
- Appendix B Training Elements
- Appendix C Glossary of Terms

## I. Introduction

Harvard University has implemented a Hearing Conservation Program (HCP) to ensure that all employees, staff members, and students who are exposed to hazardous noise levels are adequately protected to prevent hearing loss. The HCP is designed to comply with the requirements established by the Occupational Safety and Health Administration's (OSHA) Occupational Noise Exposure Standard (29 CFR 1910.95). This standard requires that all Harvard employees, staff and students whose noise exposure equals or exceeds an 8-hour time-weighted average (TWA) sound level of 85 decibels, measured on the A-weighted scale (dBA) or, equivalently, a dose of 50%, enter the HCP. The 8-hour TWA of 85 dB or a dose of 50% shall also be referred to as the Action Level. A copy of the Occupational Noise Standard can be found in Appendix A of this document. Any questions, concerns or requests for interpretation of the Harvard HCP or the Occupational Noise Standard can be directed to the EH&S Department.

## II. Exposure Control

The OSHA Permissible Exposure Limit (PEL) for continuous noise is 90 dBA for an 8-hour TWA. When noise exposure equals or exceeds the PEL, or for higher noise levels over shorter periods (Table 1), feasible administrative or engineering controls shall be implemented. Administrative controls are changes in job function to reduce the duration of noise exposure. Engineering controls are physical modifications to noise sources and surrounding areas to reduce noise exposure. If administrative or engineering controls fail to reduce levels below limits established in Table 1, then hearing protection shall be provided to reduce these levels. Exposure to or above 115 dBA for any length of time shall not be permitted without proper hearing protection. The maximum excursion level allowed by OSHA for impulse noise is 140 dB.

Table 1

Duration per day, hours	Sound level dBA slow response	
>8	85	Action Level
8	90	OSHA PEL
6	92	
4	95	
3	97	
2	100	
1 ½	102	
1	105	
½	110	
¼ or less	115	

## III. Sampling Methods

Noise dosimeters are used for sound measurements. All continuous, intermittent or impulse sound levels from 80 – 130 dBA will be integrated through the exposure computation. All dosimeters are calibrated before and after each day's use.

#### **IV. Monitoring**

When data indicate that exposure may equal or exceed the Action Level, Harvard University EH&S will perform monitoring.

The monitoring will include:

- a. A sampling strategy to identify employees for inclusion in the hearing conservation program.
- b. Appropriate instrumentation used to measure noise exposure that is calibrated to ensure measurement accuracy.
- c. Personal sampling.
- d. Opportunity for employees, staff members and students or their representatives to observe noise monitoring.
- e. Monitoring whenever a change in production, process, equipment or controls increases noise exposure.
- f. Written notification to each employee, staff member or student exposed at or above the Action Level from the monitoring.

#### **V. Audiometric Testing**

Audiometric testing is required of all employees, staff and students whose noise exposures equal or exceed the Action Level, or who have shorter periods of exposure at higher levels of noise (Table 1). The supervisor is responsible for scheduling this testing during normal work hours.

Audiometric tests are performed by a licensed or certified audiologist, otolaryngologist, or other physician, or by a technician who is certified by the Council of Accreditation in Occupational Hearing Conservation. A technician who performs audiometric tests must be under the direction of an audiologist, otolaryngologist or physician.

A baseline audiogram must be obtained within 6 months of the employee's, staff member's or student's first measured exposure to noise above the Action Level.

Testing to establish a baseline audiogram shall be preceded by at least 14 hours without exposure to workplace noise. Hearing protectors may be used towards this end. The supervisor shall notify staff of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination.

Audiograms are required at least annually after obtaining the baseline audiogram. The supervisor shall obtain a new audiogram for each employee exposed at or above the Action Level.

Each employee's, staff member's and student's annual audiogram shall be compared to his/her baseline audiogram to determine if the audiogram is valid and if there has been a standard threshold shift\*

\* Definition in Appendix D, Glossary of terms.

If the annual audiogram shows that an employee, staff member or student has suffered a standard threshold shift, the individual may obtain a retest within 30 days and consider the results of the retest as the annual audiogram.

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

- a. A copy of the requirements for hearing conservation.
- b. The baseline audiogram and most recent audiogram of the individual to be evaluated.

If a comparison of the annual audiogram to the baseline audiogram indicates a standard threshold shift, the employee, staff member or student shall be informed of this fact, in writing, within 21 days of the determination.

Unless a physician determines that the standard threshold shift is not work-related or aggravated by occupational noise exposure, the supervisor shall ensure that the following steps are taken:

- a. Employees, staff members and students not using hearing protectors shall be fitted with hearing protectors, trained in their use and care, and required to use them.
- b. Employees, staff members and students 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. Employees, staff members and students shall be referred for a clinical audiological evaluation or an otological examination, as appropriate, if additional testing is necessary or if the supervisor suspects that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors.
- d. Employees, staff members and students are 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.

## **VI. Standard Threshold Shift**

The Occupational Safety and Health Administration definition of a STS is a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more at the 2000, 3000 or 4000 Hz frequency in either ear. The STS is used as an early indicator to identify those employees, staff members or students with deteriorating hearing.

Employees, staff members and students must be notified of their STS within 21 calendar days from the date their audiometric test showed the STS. In addition to the notification, the individual must be refitted and re-trained with the appropriate hearing protection devices. The hearing protection devices should offer greater attenuation to the current noise levels.

## **VII. Hearing Protection Devices**

The supervisor shall make hearing protection available to all employees, staff and students in his/her department whose noise exposure levels are equal to or exceed the Action Level. Hearing protection is provided at no cost to the individual and shall be replaced at no cost as necessary. Manufacturers assign hearing protectors a Noise Reduction Rate (NRR), which is a level of noise reduction the hearing protectors will give if worn properly. It is important to note that when working with A-weighted noise levels, one must subtract an additional 7 dB from the labeled NRR to obtain an estimate of the A-weighted noise level under the protector. Contact EH&S before purchasing hearing protection to ensure that adequate protection will be provided to the user. *Note: Personal headphones are not hearing protection devices.*

It is the department supervisor's responsibility to ensure that hearing protectors are worn by employees, staff and students enrolled in the HCP. In addition, those participants who are exposed at or above the Action Level and have yet to have a baseline audiogram are required to wear hearing protection.

The following requirements for hearing protectors are:

- a. Must attenuate employee exposure to an 8-hour TWA below 90 dB.
- b. Employees, staff and students who have experienced a standard threshold shift must have hearing protectors that attenuate employee exposure to an 8-hour TWA of 85 dBA or below.
- c. Adequacy of hearing protector attenuation shall be re-evaluated whenever the employee's, staff member's or student's noise exposure increases to the extent that the hearing protectors provided may no longer provide adequate attenuation. The supervisor shall provide more effective hearing protectors where necessary.

## **VIII. Noise Placards**

Noise placards must be posted where employees, staff and students are exposed to the Action Level or above. The placards must indicate the area as a High Noise Area or the specific operation as a High Noise Operation. In addition to the written sign, the degree of hearing protection is also required for the area or operation.

## **IX. Training**

Harvard University EH&S will provide initial and annual training to all employees, staff and students who are exposed to noise at or above the Action Level. The department supervisors are responsible for employee, staff and students participation in the HCP training.

The training will include:

- a. Effects of noise on hearing
- b. Purpose of hearing protectors
- c. Advantages, disadvantages, and attenuation of various types of hearing protection devices.
- d. Instruction on selection, fitting and use of hearing protectors
- e. Purpose of audiometric testing
- f. Explanation of the test procedures
- g. Access to audiometric records and training materials.

Contents of the training can be found in Appendix B.

Information provided in the training program shall be reviewed annually to be consistent with changes in protective equipment and work processes. All participants completing the training will have their name and affiliation entered in EH&S's central training database.

## **X. Record keeping**

Harvard University department supervisors are required to keep all noise exposure measurements, copies of noise exposure reports and audiometric test records for employees, staff and students.

All audiometric test records shall include the following:

- a. Name of employee, staff or student
- b. Job classification
- c. Date of the audiogram
- d. Examiner's name
- e. Date of the last acoustic or exhaustive calibration of the audiometer
- f. The employee's, staff member's or student's most recent noise exposure assessment.
- g. Measurements of the background sound pressure levels in audiometric test room.

All noise exposure measurement records shall be retained for a minimum of two years. Audiometric test records shall be retained for the duration of the affected employee's, staff member's or student's affiliation with the department.

All records shall be provided upon request to affected current and past employees, staff members, and to representatives designated by these individuals, and to the responsible regulatory agencies.

If the supervisor leaves his position, he/she shall transfer to his/her successor all records pertaining to noise of the affected individuals. The successor shall retain those records for the remaining duration of the affected individuals' affiliation with the department.

**Appendix A**  
**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:

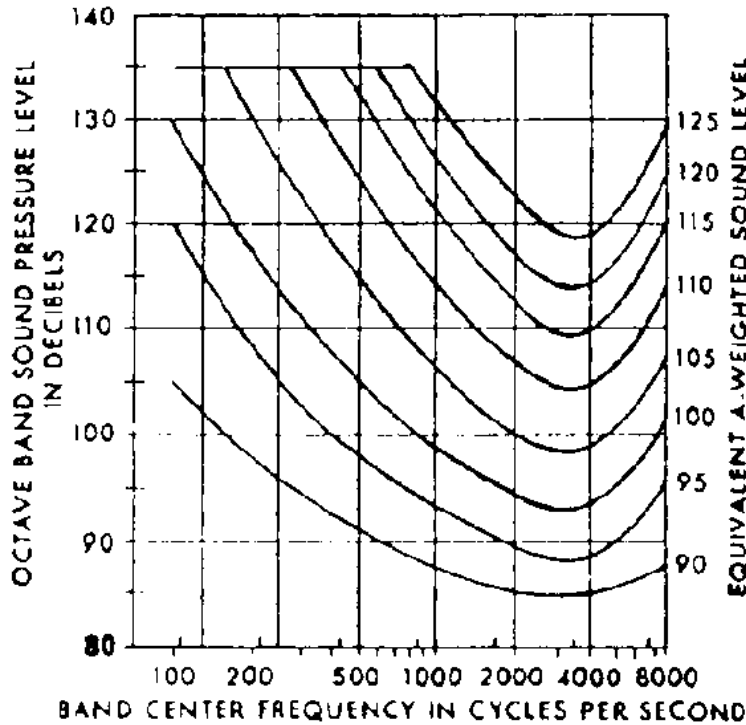


FIGURE G-9

Figure G-9

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

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

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

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:  $C(1)/T(1) + C(2)/T(2) + \dots + C(n)/T(n)$  exceeds unity, then, the mixed exposure should be considered to exceed the limit value.  $C_n$  indicates the total time of exposure at a specified noise level, and  $T_n$  indicates the total time of exposure permitted at that level. Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

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

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

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

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

(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 §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.

## **Appendix B. Hearing Conservation Training Elements**

Harvard University's Environmental Health and Safety Department provides initial and annual training to all employees, staff and students who are enrolled in the hearing conservation program or are exposed to noise at or above an 8-hour TWA of 85 dBA. It is vital that all enrollees participate in the annual hearing conservation training. The following topics are key parts to the Hearing Conservation Program.

### **Effects of Noise On Hearing**

Short-term exposure to high noise levels may result in a temporary change in hearing. This type of noise exposure may have your ears experience a stuffy feeling or a temporary ringing. These short-term exposures to high noise levels usually go away after periods of non-exposure. However, repeated exposure to high noise levels can lead to permanent, incurable hearing loss or tinnitus\*.

Occupation noise is the most common type of hearing loss. During the course of a noisy day, the ear becomes fatigued and the person will experience a temporary threshold shift (TTS)\*. If no exposure occurs after work, the loss will often disappear by morning. If a TTS occurs over a long duration, the loss becomes a permanent threshold shift (PTS)\*. A PTS occurs when the ear does not have enough recovery time from a TTS before the next noise exposure.

### **Purpose of Hearing Protectors**

Hearing protectors can be very effective, but only if fitted and worn properly. When required, Harvard University offers two types of hearing protection: ear muffs and ear plugs. Worn correctly, hearing protection reduces noise exposure equal to or below 85 dBA.

### **Advantages, Disadvantages, and Attenuation of Various Types of Hearing Protection Devices.**

There are many advantages and disadvantages of ear plugs and ear muffs. Ear plugs are cheap and readily available. They are easy to carry and are convenient to use with other personal protection equipment. They are also more comfortable than ear muffs in hot and confined areas. However, the disadvantages of ear plugs are that there are so many different types of plugs and they have different levels of effectiveness. Ear plugs are not recommended for use in areas where the noise level exceeds 105 dBA. In addition, ear plugs require more time to fit, are sometimes difficult to insert or remove and can irritate the ear canal. The ear plugs effectiveness depends on how well they are fitted in the ear canal.

The common advantages of ear muffs are their simplicity to remove and replace. In addition, ear muffs cover the entire ear, so you do not have to worry as much about proper fitting. Ear muffs are more sanitary than inserted plugs because they remain outside the ear, which makes sharing ear protection a safer alternative. Ear muffs are also generally more comfortable than most alternatives because nothing is inserted in the ear canal. The disadvantages of ear muffs are they are uncomfortable in a hot area and need to be stored in a clean environment. Ear muffs are more expensive than ear plugs and more inconvenient to use with other personal protective equipment. Ear muffs may also interfere with those who wear prescription glasses which results in breaking the seal between the earmuff and the skin decreasing the hearing protection.

All ear plugs and ear muffs are assigned a Noise Reduction Rate (NRR) by the manufacturer. It is important to note that when working with A-weighted noise levels, one must subtract an additional 7 dB from the labeled NRR to obtain an estimate of the A-weighted noise level under the protector. Most ear plugs have a NRR of 20-35 dB and ear muffs a NRR of 25-30 dB. Ear muffs and plugs can be combined for even more noise reduction

### **Instruction on Selection, Fitting and Use of Hearing Protectors**

Harvard University has selected to offer both soft foam ear plugs and ear muffs for protection against noise exposure. Although ear muffs attenuate noise in high frequencies nearly as well as foam ear plugs, the foam ear plug is better at reducing exposure to low frequency noise if worn properly.

Steps for inserting foam ear plugs:

1. Your hand and ear should be clean before inserting the ear plugs
2. Slowly roll and compress foam plugs into a fine cylinder.
3. While compressed, insert the plug into the ear canal.

*Note: fitting the ear plug inside the canal may be easier if you reach around the ear to pull the ear outward and up during insertion.*

4. Once the ear plug is in the ear canal, the foam will expand making a snug seal in the ear canal.

To test the effectiveness of the ear plugs, cover and uncover your ears with tightly pressed hands. If the plugs are properly fitted, the noise levels should seem nearly the same whether the ears are covered or not covered. Disposable ear plugs may be reused if they are kept clean and are still pliable.

Steps for wearing ear muffs:

1. Place the ear muffs over the head and adjust the straps for a comfortable fit.
2. The ear muffs must fully enclose the ears and have a seal against the head to be most effective.
3. For men or woman with long hair, pull the hair back and away from the muffs to create a seal around the ear.
4. Items such as pencils or ball caps should never be worn under the cushions of the muffs.
5. Those donning safety glasses should also adjust the temples so they do not break the ear muff seal.

Ear muffs should be stored in a dust-free environment and kept clean at all times. The cushions on the muffs must be soft and flexible and should be replaced when they become cracked or dented.

### **Purpose of Audiometric Testing**

Audiometric testing is an essential part of the Harvard University Hearing Conservation Program. The audiometric testing of employees, staff and students displays the effectiveness in preventing occupational noise exposure that can cause hearing loss. The purpose of the audiometric tests is to identify hearing loss.

### **Explanation of the Audiometric Test Procedures**

The audiometer and each headset is calibrated

Employee will fill out a hearing history questionnaire.

A technician will examine the person's ears with an otoscope.  
The employee is then seated in the sound reduction booth and the hearing test is administered.  
At the completion of the test, a computer automatically compares the employees' current test to the baseline.  
A letter of interpretation is printed from the test.  
The technician will briefly review the results of the test with the employee.  
The employee will sign the notification letter.  
If the testing shows that the employee has an unusual result or has sustained a standard threshold shift, the licensed Occupational Health Services audiologist will review the test.

**Access to Audiometric Records and Training Materials.**

Audiometric test records shall be retained for the duration of the affected employee's employment. All audiometric records and training materials shall be provided upon request to current and former employees, staff, students, representatives designated by the affected employee, staff or student and the Assistant Secretary.

## **Appendix C**

### **Glossary of Terms**

#### **ATTENUATION**

The reduction of sound energy as a function of distance traveled.

#### **A WEIGHTING**

An electronic filtering system in a sound meter that allows meter to largely ignore lower frequency sounds in a similar fashion to the way our ears do.

#### **AMBIENT NOISE/SOUND**

Noise level in a space from all sources such as HVAC or extraneous sounds from outside the space. Masking sound or low-level background music can contribute to ambient level of sound or noise.

#### **AUDIOGRAM**

Graph of hearing threshold level as a function of frequency (ANSI S3.20-1995: audiogram).

#### **AUDIOMETER**

An instrument for measuring hearing acuity.

#### **BASELINE AUDIOGRAM**

The audiogram obtained from an audiometric examination administered before employment or within the first 30 days of employment that is preceded by a period of at least 12 hr of quiet. The baseline audiogram is the audiogram against which subsequent audiograms will be compared for the calculation of significant threshold shift.

#### **CONTINUOUS NOISE**

Noise with negligible small fluctuations of level within the period of observation (ANSI S3.20-1995: stationary noise; steady noise).

#### **DECIBEL (dB)**

Unit of level when the base of the logarithm is the 10th root of 10 and the quantities concerned are proportional to power (ANSI S1.1-1994:decibel).

#### **DECIBEL, A-WEIGHTED (dBA)**

Unit representing the sound level measured with the A-weighting network on a sound level meter. (Refer to Table 4-1 for the characteristics of the weighting networks).

#### **DOSE**

The amount of actual exposure relative to the amount of allowable exposure, and for which 100% and above represents exposures that are hazardous. The noise dose is calculated according to the following formula:

$D = \{C_1/T_1 + C_2/T_2 + \dots + C_n/T_n\} H 100$  where  $C_n$  = total time of exposure at a specified noise level  $T_n$  = exposure time at which noise for this level becomes hazardous

## **NOISE**

(1) Undesired sound. By extension, noise is any unwarranted disturbance within a useful frequency band, such as undesired electric waves in a transmission channel or device.

(2) Erratic, intermittent, or statistically random oscillation (ANSI S1.1-1994: noise).

## **NOISE CRITERIA (NC)**

Noise criteria curves used to evaluate existing listening conditions at ear level by measuring sound levels at loudest locations in a room. NC criteria can be referred to equivalent dBA levels. NC curves are critical to persons with hearing loss.

## **NOISE REDUCTION RATING (NRR)**

The NRR, which indicates a hearing protector's noise reduction capabilities, is a single-number rating that is required by law to be shown on the label of each hearing protector sold in the United States. Unit, dB.

## **OTOLARYNGOLOGIST**

A medical doctor specializing in the diagnosis and treatment of ear, nose and throat disorders.

## **PERMANENT THRESHOLD SHIFT (PTS)**

Permanent increase in the threshold of audibility for an ear. Unit, dB (ANSI S3.20-1995: permanent threshold shift; permanent hearing loss; PTS).

## **PRESBYCUSIS**

The loss of hearing due primarily to the aging process. High frequency loss is frequently a result of early hearing loss.

## **SIGNIFICANT THRESHOLD SHIFT**

A shift in hearing threshold, outside the range of audiometric testing variability (5 dB), that warrants follow-up action to prevent further hearing loss. NIOSH defines significant threshold shift as an increase in the HTL of 15 dB or more at any frequency (500, 1000, 2000, 3000, 4000, or 6000 Hz) in either ear that is confirmed for the same ear and frequency by a second test within 30 days of the first test.

## **TEMPORARY THRESHOLD SHIFT**

Temporary increase in the threshold of audibility for an ear caused by exposure to high-intensity acoustic stimuli. Such a shift may be caused by other means such as use of aspirin or other drugs. Unit, dB. (ANSI S3.20-1995: temporary threshold shift; temporary hearing loss).

## **TIME WEIGHTED AVERAGE (TWA)**

The averaging of different exposure levels during an exposure period. For noise, given an 85-dBA exposure limit and a 3-dB exchange rate, the TWA is calculated according to the following formula:  $TWA = 10.0 H \text{Log}(D/100) + 85$  where  $D$  = dose.

**TINNITUS**

'Ringing in the ears' of which there is no observable cause.

**THRESHOLD SHIFT**

The deviation in decibels of a measured hearing level from one previously established