Hearing Conservation Program

DARTMOUTH

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Section 1 – Purpose

The Dartmouth College Hearing Conservation Program serves to minimize the potential for occupational noise induced hearing loss using effective control methods. The purpose of this program is to establish and implement procedures to reduce noise exposure, perform dosimetry and noise mapping, and audiometric testing procedures.

Section 2 – Scope

The Occupational Health and Safety Administration (OSHA) Noise Exposure standard 29 Code of Federal Regulations (CFR) 1910.95 established a permissible exposure limit (PEL) for occupational noise exposure, defines requirements for audiometric testing, personal protective equipment (PPE), and user training. This standard has established an 8-hour TWA action level (AL) of 85 dBA. When noise levels are at or above this level then a hearing conservation program is required. The basic components of this hearing conservation program include:

1) Noise Monitoring, 29 CFR 1910.95(d)(e)(f)
2) Engineering and Administrative Controls, 29 CRF 1910.95(a)(b)
3) Audiometric Evaluation, 29 CFR 1910.95(g)(h)
4) Hearing protection, 29 CFR 1910.95(i)(j)
5) Education and training, 29 CFR 1910(k)(l)
6) Recordkeeping, 29 CFR 1910.95(m)
7) Program Evaluation, 29 CRF 1910.95 Appendices A and B and ANSI S12.13

The goal of the Dartmouth College Hearing Conservation Program is to minimize the potential for occupational noise induced hearing loss in accordance with 29 CFR 1910.95. Dartmouth College (Dartmouth) will work to achieve this goal as outlined in this Hearing Conservation Program for its employees.

All elements of the Dartmouth Hearing Conservation Program apply where the sound levels equal or exceed an 8-hour time-weighted average (TWA) of 85 decibels measured on the A-scale (dBA).

Contractors, suppliers, vendors, and visitors exposed to hazardous noise levels must wear approved hearing protection but are not included in Dartmouth's Hearing Conservation Program.

A copy of this program is available on the EHS website, and shall be provided to all faculty, staff, and students enrolled in the program upon request.

Questions about this program should be directed to Environmental Health and Safety at 603-646-1762 or at ehs@dartmouth.edu.

Section 3 – Definitions

5-dB exchange rate - for every 5dB increase in noise level, the allowable exposure time is reduced by half. This exchange rate is used by OSHA.

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.

Administrative Controls - measures taken to reduce workers' noise exposure including adjustments to their schedules, locations, or the operating schedule of noisy machinery. These efforts are typically undertaken by management in order to limit the impact of noise on workers' health and well-being.

Audiogram - a chart, graph of table resulting from an audiometric test showing an individual's hearing threshold 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 examiners.

ANSI - American National Standards Institute.

A-scale - an expression of the relative loudness of sounds as perceived by the human ear. A-weighting gives more value to frequencies in the middle of human hearing and less value to frequencies at the edges as compared to a flat audio decibel measurement.

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

Baseline Audiogram - a valid audiogram against which subsequent audiograms are compared to determine if hearing thresholds have changed. The baseline audiogram is preceded by a quiet period so as to obtain the best estimate of a person's hearing at that time.

Decibel - a unit used to measure the intensity of a sound or the power level of an electrical signal by comparing it with a given level on a logarithmic scale.

dBA - decibels of sound on the A-weighted scale.

Dosimeter - refers to an instrument specifically designed to measure sound levels over a defined period. It records and stores the measured data, and calculates various parameters related to sound exposure, such as dose, time-weighted average (TWA), peak level, equivalent sound level, sound exposure level, and others. A sound dosimeter provides a comprehensive assessment of an individual's exposure to noise by considering both the sound level and the duration of exposure. It is a valuable tool for

evaluating occupational noise exposure and assessing compliance with noise regulations and guidelines.

Engineering Controls - these engineering methods refer to techniques employed to reduce or control the sound level of a noise source by making modifications or replacements to equipment, as well as implementing physical changes at the noise source or along the transmission path.

Exchange rate - the trade-off relationship between an increase (or decrease) in sound level and corresponding change in allowed exposure duration; when the sound level increases by the decibel value of the exchange rate, the permitted duration is halved.

Frequency - the wave oscillation rate at a fixed position in space or in a solid medium, expressed in hertz (Hz).

Hertz (Hz) is a unit of frequency measurement that is numerically equal to cycles per second. The frequency range for human hearing lies between 20 Hz and approximately 20,000 Hz. The human ear's sensitivity drops off sharply below about 500 Hz and above 4,000 Hz.

NIOSH - National Institute of Occupational Safety and Health

Noise dose - percentage of allowable daily exposure to noise. According to OSHA, a 100% dose corresponds to an 8-hour exposure to a continuous noise level of 90 dBA. A 50% dose would be equivalent to an 8-hour exposure to an 85 dBA noise level or a 4-hour exposure to a 90 dBA noise level. If the maximum permissible noise level is 85 dBA, an 8-hour exposure to a continuous 85 dBA noise would result in a 100% dose. However, if a 3 dB exchange rate is utilized with the 85 dBA maximum permissible level, a 50% dose would correspond to either a 2-hour exposure to 88 dBA or an 8-hour exposure to 82 dBA. The exchange rate of 3 dB means that for every 3 dB increase in noise level, the allowed exposure time is halved to maintain the same dose. These dose calculations assess the cumulative impact of noise exposure on an individual over a given period.

Noise Reduction Rating (NRR) - Noise Reduction Rating is a unit of measurement used to determine the effectiveness of hearing protection devices in decreasing sound exposure within a given working environment. The higher the NRR number associated with a hearing protector, the greater the potential for noise reduction.

Occupational Safety and Health Administration (OSHA) – The Occupational Safety and Health Administration (OSHA) is responsible for establishing permissible exposure limits (PELs) to protect workers against the health effects of exposure to hazardous substances.

Permissible Exposure Limit (PEL) - set by OSHA, is the maximum noise an employee can be exposed to, 90 dBA averaged over an 8-hour work shift of a 40-hour work week. PELs are regulatory limits that are legally enforceable.

Personal Protective Equipment (PPE) - personal protective equipment for noise includes earmuffs and plugs.

Sound - fluctuations of pressure above and below the ambient pressure of a medium with elasticity and viscosity.

Sound Level Meter - an instrument for measuring sound level.

Sound Pressure Level (SPL) - a measurement that represents the ratio of the pressure of a sound wave to a reference sound pressure. It is expressed in decibels (dB) and is often referenced to 20 microPascals (μPa). When the term SPL is used alone, such as "90 dB SPL," it implies an unweighted sound pressure level. In practical terms, SPL quantifies the intensity or loudness of a sound. A higher SPL value indicates a louder sound, while a lower one indicates a quieter sound. The decibel scale is logarithmic, meaning that each increase of 10 dB represents a tenfold increase in sound intensity. For example, a sound with an SPL of 80 dB is ten times more intense than an SPL of 70 dB.

Standard Threshold Shift (STS) - a change in hearing threshold, OSHA uses the term to describe a change in hearing threshold relative to the baseline audiogram for that employee, of an average of 10 decibels (dB) or more at 2,000, 3,000, and 4,000 hertz (Hz) in one or both ears. NIOSH uses this term to describe a change of 15 dB or more at any frequency, 500 through 6,000 Hz, from baseline levels present on an immediate retest in the same ear and at the same frequency.

Temporary and Seasonal Workers - defined as one who works no more than six months in one year, commencing on the temporary employee's date of hire.

Time-weighted Average (TWA) - a computed value expressed in dBA so that the resulting average would be equivalent to an exposure resulting from a constant noise level over 8 hours.

Section 4 – Roles and Responsibilities

The Hearing Conservation Program roles and responsibilities are identified and delineated below. The duties and responsibilities of EHS, supervisors, employees, and other groups at Dartmouth play an essential role in supporting this program's successful implementation and maintenance. The success of the Hearing Conservation Program relies on and charges Dartmouth employees to adhere to, follow, and provide full support of this Program.

4.1 Environmental Health and Safety (EHS)

1) Develop, implement, and maintain an OSHA-compliant Hearing Conservation Program.
2) Conduct periodic hazard assessments to include noise exposure monitoring and/or noise surveys with supervisors' input to determine areas and tasks that may be at or near the 8-hour TWA of 85 dBA using the Noise Notification form in Appendix B.

3) Maintain noise monitoring equipment.
4) Maintain noise assessments, training records, and audiometric test records.
5) Provide a summary of the survey results to the supervisor and each employee involved in the sound survey(s).
6) Assist supervisors of employees experiencing standard threshold shifts in filing out Injury and Illness reports to be submitted to Risk Management.
7) Audit this program and its participants periodically to assess compliance and ensure program viability.
8) Evaluate and select appropriate hearing protection devices for each employee based on proper fit, noise exposure, hearing ability, communication needs, personal preferences, and job-related constraints.
9) Provide training and motivation for wearing hearing protection.
10) Assess attenuation characteristics of the hearing protectors to sufficiently reduce exposure to the required decibel levels, as outlined below:
    a) If the 8-hour TWA exceeds 90 dBA, the protector must attenuate the exposure to an 8-hour TWA of 90 dBA or below.
    b) If the protector is worn due to an employee's experience of an STS, it must attenuate the exposure to an 8-hour TWA of 85 dBA or below.
    c) If employee noise exposure increases to a level where the provided hearing protectors no longer offer adequate attenuation, more effective hearing protectors will be provided.

4.2 Supervisors

1) Adhere to the requirements of this program.
2) Identify noisy tasks and request EHS assistance to determine the noise exposure associated with those tasks.
3) Ensure employees participate in baseline and annual audiometric evaluations.
4) Communicate with EHS to schedule baseline and annual audiometric evaluations.
5) Lead by example by requiring all personnel, including supervisors and visitors, to wear hearing protectors in designated areas and promote the use of protectors outside of designated areas during noisy activities.
6) Complete Accident/Incident report(s) within 24 hours and submit the report to Risk and Internal.
7) Ensure employees wear hearing protectors in the following cases:
    a) When an employee is exposed to sound levels that are equal to or exceed an 8-hour TWA of 90 dBA.
    b) When an employee has experienced a persistent standard threshold shift (STS) and is exposed to an 8-hour TWA of 85 dBA or higher.
    c) When an employee has not undergone an initial baseline audiogram and is exposed to an 8-hour TWA of 85 dBA or higher.

4.3 Employees

1) Adhere to the requirements of this program.
2) Wear Dartmouth-supplied or approved hearing protection whenever required and as needed for noisy tasks.
3) Participate in the baseline and audiometric evaluations.
4) Assist their supervisors and EHS in identifying tasks that may require hearing protection.
5) Notify the supervisor about any changes they observe in the equipment or its placement.
6) Choose their hearing protectors from various suitable options, provided at no cost.
7) Proper use and maintenance of the provided equipment. Proactively check protectors for wear and tear, and seek repairs or replacements when needed.
8) Regularly inspect and replace deteriorated noise control measures necessary to maintain noise reduction.
9) Share knowledge with colleagues on properly using engineering controls and hearing protectors.
10) Notify supervisors and EHS regarding any health and safety concerns.

4.5 Risk and Internal Controls Services (RICS)

1) Maintain injury log.

4.6 Facilities, Operation, and Management (FO&M)

1) Be the point of contact for scheduling a mobile test van to arrive on campus to perform baseline and annual audiometric testing on-site.
2) Coordinate audiometric testing schedule with supervisors for baseline and annual audiometric evaluations.

4.7 Audiometric Testing Provider

1) Adhere to the requirements of this program.
2) Conduct baseline audiometric evaluations.
3) Conduct annual audiometric tests and determine if employees experience a standard threshold shift (STS).
4) Provide EHS with a list of employees who have experienced an STS.
5) Provide EHS with a copy of the audiometric test results.
6) Maintain and calibrate all audiometric testing equipment according to industry and OSHA standards.

Section 5 – Noise Monitoring

Through risk ranking and exposure monitoring, Dartmouth can proactively identify, assess, and manage noise-related risks, leading to the implementation of appropriate control measures and the preservation of individuals' hearing health.

1) Dartmouth's Hearing Conservation Program must monitor employees exposed to noise at or above the OSHA AL of 85 dBA averaged over an 8-hour day with a 5 dB exchange rate. The measurement must include continuous, intermittent, and impulsive sounds within an 80 to 130 dB range, and during typical tasks.
2) Instruments used during noise monitoring must be calibrated annually per manufacturer guidelines and are pre- and post-calibrated for each sampling event.
3) Monitoring will be repeated whenever changes occur in the production, process, or controls. These changes may result in different hearing protection and/or additions/removals to/from the Hearing Conservation Program.
4) If desired, individuals participating in the program are entitled to observe the monitoring procedures and will also receive written notification of noise exposure results via email or mail.
5) Noise monitoring data will be collected and maintained on standardized forms.

Section 6 – Audiometric Testing Program

Employees exposed to noise levels at or above the OSHA AL 8-hour TWA of 85 dBA are required to participate in audiometric testing, provided at no cost to employees. The process for audiometric testing is as follows:

1) Within six months of the employee's start date, a qualified provider will conduct a baseline test. Note: if a mobile hearing van is used, a baseline test will be conducted within one year.
2) Before baseline testing, supervisors must ensure employees have not been exposed to occupational noise or have properly worn hearing protectors for at least 14 hours before the baseline test.
3) Audiometric testing will be performed annually to monitor employees' hearing status.
4) All employees will receive a detailed report of their audiometric testing that explains test results, medical history, and appropriate recommendations provided by the tester.
5) EHS will notify employees within 21 days after determining that their audiometric test results show a Standard Threshold Shift (STS).
6) If an STS is detected during annual audiometric testing, the employee can undergo a retest within 30 days. The results of the re-test will be considered as the annual audiogram.
7) If an STS is confirmed, the following actions must be taken:

a) Employees not wearing hearing protection will be provided with hearing protectors and trained in their proper use and maintenance.
b) Employees already using hearing protectors will be refitted and retrained in the proper use of hearing protectors to reduce employee TWA exposure below 85 dBA effectively. They will be provided with hearing protectors that offer greater noise attenuation if necessary.
c) Test results will be reviewed by an audiologist, otolaryngologist, or physician who will determine if further evaluation or retraining is necessary.

8) An annual audiogram may replace the baseline audiogram (i.e., become the revised baseline) if the evaluating audiologist, otolaryngologist, or physician determines:
   a) The STS identified in the audiogram is persistent, or
   b) The hearing threshold indicated in the annual audiogram shows significant improvement compared to the baseline.
9) If an employee's job duties change, and they are no longer exposed to a TWA of 85 dBA, they will still be required to complete at least one additional annual audiogram as regularly scheduled.
10) Approved audiometric testing vendors:
   a) Mobile audiology services
      i) Fiske Mobile Hearing Services
         Windy Knoll Village
         62 Portsmouth Ave., Stratham, NH 03885
         Phone: (603) 778-7620
      ii) Fiske Mobile Hearing Services
         Jackson Gray Medical Building
         330 Borthwick Ave., Ste. 209, Portsmouth, NH 03801
         Phone: (800) 778-7620
   b) Dartmouth Hitchcock Medical Center, Audiology
      1 Medical Center Drive, Lebanon, NH 03756
      Phone: (603) 650-8123
11) Audiometric testing must adhere to the guidelines and requirements outlined in Appendix C: OSHA Mandatory Appendices.
12) Audiometric testing will be provided to employees at no cost if required by this program.

6.1 Temporary and Seasonal Employees

The OSHA Noise Exposure standard 29 CFR 1910.95 doesn't provide a specific exclusion from audiometric testing for temporary or seasonal workers. However, the March 8, 1983, preamble to the hearing conservation amendment final rule explained that OSHA incorporated time frames for acquiring a baseline audiogram in sections 1910.95(g)(5)(i) and (ii) to exempt seasonal and temporary workers from the audiometric testing program. OSHA clarified that conducting

audiometric testing for these workers would pose administrative challenges or might not be feasible due to their work patterns with multiple employers throughout a season or year.

Therefore, Dartmouth's temporary and seasonal employees are exempt from the mandatory audiometric testing program. A temporary or seasonal employee shall be defined as one who works no more than six months in one year commencing on the temporary employee's date of hire.

Section 7 – Controlling Noise Exposure

Once the cause or source of noise in a workplace is identified and the extent of its impact on employee work areas is determined, the next step is to consider the available options for noise control. The most effective control measure to reduce noise is to eliminate the source. If this isn't feasible, engineering controls should be employed to lower noise levels. Alternatively, minimizing time spent within noisy environments will reduce exposure. The last and least reliable control method is personal protective equipment. Below is a summary of control methods listed in order of effectiveness.

7.1 Elimination or Substitution

The most effective control method is to eliminate the hazard by substituting it for an alternative, safer method or process. This can involve selecting and using equipment specifically designed to operate with reduced noise levels or alternative processes or materials that generate less noise.

7.2 Engineering Controls

Engineering controls involve changing the source to reduce noise generation or modifying the surrounding environment to reduce noise. This may include making physical modifications such as installing mufflers to machinery, adding acoustic enclosures around the machinery, using vibration isolation techniques, or installing sound-dampening materials to treat the area acoustically. In some cases, relocating the noise source away from employee work areas can be a practical option. This may involve rearranging the workspace layout, moving noisy equipment to dedicated rooms or enclosures, or reorganizing workflow to minimize noise exposure.

7.3 Administrative Controls

Administrative controls are the modification of work practices and the implementation of new policies and procedures. The most effective administrative noise control measure is to prevent the entry of noise into the work environment. One way to achieve this is by implementing a "buy-quiet" program, which focuses on purchasing equipment and machinery with low noise emissions. Additional administrative controls could include worker rotation/limiting the duration of selected worker job activities. However, it's important to note that rotating employees in this manner will increase the number of employees exposed to the noise source(s) of concern.

7.4 Personal Protective Equipment (PPE)

Various types of hearing protection will be offered to all employees at no cost, who are exposed to or likely to be exposed to noise levels at or above the OSHA action level of 85 dBA.

1) The following employees are required to wear hearing protection:
   a) Employees are exposed to a TWA of 90 dBA or higher.
   b) Employees exposed to a TWA of 85 dBA or higher who have not undergone a baseline audiogram.
   c) Employees exposed to a TWA of 85 dBA or higher and who have experienced a Standard Threshold Shift (STS).
2) The guidelines for using hearing protection are as follows:
   a) Employees will receive training on properly using and maintaining the provided hearing protection. For more details, see Section 8 Training, Education and Motivation.
   b) Hearing protection will be replaced as needed to ensure its effectiveness.
   c) The hearing protection must have a Noise Reduction Rating (NRR) sufficient to reduce the noise exposure below the 85 dBA action level.

7.5 Noise Reduction Rating (NRR)

The noise reduction rating (NRR) is a standardized descriptor used to estimate the level of noise reduction provided by a hearing protection device. The NRR is a precalculated value supplied by manufacturers and is typically indicated on the packaging of the hearing protection device.

The NRR is used to estimate the wearer's noise exposures as shown in Equation 1 below:

Equation 1

Estimated exposure (dBA) = TWA (dBA) – ((NRR – 7dB) x 50%)

e.g., If an employee is exposed to a TWA of 92 dBA and is wearing earplugs with an NRR of 25, their actual exposure would be 83 dBA = 92 dB – ((25 – 7) x 0.5).

7.5.1 Dual Protection

Dual hearing protection is wearing two forms of hearing protection simultaneously (e.g., earplugs and earmuffs). Using dual protection will add 5 dB of attenuation.

e.g., Using the same example, if the employee adds NRR 30 earmuffs over the NRR 25 earplugs, the employee will have 83 dBA exposure minus an additional five dBA for a final exposure of 78 dBA.

7.6 Special Program Requirements

Radio-style earmuffs/earbuds, Bluetooth-compatible or similar noise-isolating devices must meet applicable American National Standards Institute (ANSI) S3. 19-1974 and OSHA standards. Such devices must be pre-approved by the employee's supervisor and EHS.

Section 8 – Training, Education, and Motivation

If educational content is relevant and sincerely presented, the resulting impact on participation in the Hearing Conservation Program can be significant. The training must be simple, short, meaningful, and motivating.

1) All employees exposed to or likely to be exposed to noise levels at or above the TWA of 85 dBA must receive hearing conservation training during their onboarding and annually thereafter. The training curriculum must cover the following topics:
   a) The adverse effects of noise on hearing health.
   b) The importance of correctly fitting hearing protectors to reduce noise levels, along with their advantages and disadvantages.
   c) Detailed instructions on selecting, fitting, using, and maintaining hearing protection.
   d) An explanation of the purpose of audiometric testing and the procedures involved in the testing process.
2) Training sessions will be conducted using the following methods:
   a) Mandatory online training modules for employees are included in this program.
   b) Additional awareness in-person training sessions conducted by personnel from EHS and/or supervisors for those employees requiring follow-up action (e.g., employees who experienced an STS, possible STS, or significant loss of baseline).
   c) Online awareness training for students exposed to noise levels equal to or greater than 85 dBA due to laboratory activities, clubs, and/or extra-curricular activities.

Section 9 – Recordkeeping

Effective Hearing Conservation Programs include recordkeeping of audiometric comparisons, hearing protector training reports, and exposure measurement analysis. Dartmouth is required to maintain accurate records.

1) Dartmouth Environmental Health and Safety (EHS) will retain the following records:
   a) Noise monitoring data for a period of thirty years.
   b) Training records for a period of three years.
   c) Audiometric test records

Access to these records is granted to employees, former employees, and representatives designated by individual employees upon request.

Upon written request, all records will be transferred to the successor employer.

Section 10 – Program Evaluations

The Hearing Conservation Program will be evaluated annually by EHS using the Program Evaluation Checklist.

Appendix A – Recommended Signage

This is an example of a sign that should be posted in areas with noise levels at or above the 85 dBA threshold.

This is an example of a sign that should be posted in areas with intermittent noise above the 85 dBA threshold.

Appendix B – Personal Noise Monitoring Report

Personal Monitoring					
Building #:		Area:		Date:	
Person Conducting Sampling:				Shift Length:	
Nature of Work (include controls):					
Monitor Used:		Serial #:		Annual Calibration Date:	
Calibrator:		Serial #:		Annual Calibration Date:	
Pre-Calibration (dBA)		Post-Calibration (dBA)		Change:	
Employee:			Employee #:		
Supervisor:			Supervisor Ext:		

Time	Results			Occupational Exposure Limits			Comments
	OSHA TWA 80 (dBA) 1	OSHA TWA 90 (dBA) 2	ACGIH TWA 80 (dBA)3	OSHA PEL (dBA)	OSHA AL (dBA) 4	ACGIH TLV (dBA)	
				90	85	85	
				90	85	85	
				90	85	85	
				90	85	85	

(1) For time-weighted (TWA) exposures equal to or greater than 85 dBA based on 8 hours, OSHA requires that the employee participate in a Hearing Conservation Program. All sounds greater than 80 dBA are included in obtaining this average noise exposure. The TWA exposure assumes equivalent exposure during shift time not sampled.

(2) OSHA requires administrative and engineering controls be evaluated and implemented if feasible whenever employees are exposed in excess of the Permissible Exposure Level (PEL) of 90 dBA for eight hours. Only sound levels greater than 90dBA are integrated in this averaging calculation.

(3) For ACGIH (TLV) exposures equal to or greater than 85 dBA based on 8 hours. Only sound levels > 80 dBA are integrated in this averaging calculation with a 3 dB exchange rate.

(4) For extended work shifts the Action Level (AL) for noise must be reduced for extended work shifts based on the following formula: New AL (dBA) = 90 + 16.61 x log (50 / (12.5 x number of hours worked))

Employee Signature	Date
Supervisor Signature	Date

Appendix C – OSHA § 1910.95 Mandatory Appendices

§ 1910.95 – 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:

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

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	21.2
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

A-weighted sound level, L (decibel)	Reference duration, T (hour)
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	Dose or percent noise exposure	TWA	Dose or percent noise exposure	TWA	Dose or percent noise exposure	TWA
10	73.4	101	90.1	200	95	550	102.3
15	76.3	102	90.1	210	95.4	560	102.4
20	78.4	103	90.2	220	95.7	570	102.6
25	80	104	90.3	230	96	580	102.7
30	81.3	105	90.4	240	96.3	590	102.8
35	82.4	106	90.4	250	96.6	600	102.9
40	83.4	107	90.5	260	96.9	610	103
45	84.2	108	90.6	270	97.2	620	103.2
50	85	109	90.6	280	97.4	630	103.3
55	85.7	110	90.7	290	97.7	640	103.4
60	86.3	111	90.8	300	97.9	650	103.5
65	86.9	112	90.8	310	98.2	660	103.6
70	87.4	113	90.9	320	98.4	670	103.7
75	87.9	114	90.9	330	98.6	680	103.8
80	88.4	115	90.1	340	98.8	690	103.9

Dose or percent noise exposure	TWA	Dose or percent noise exposure	TWA	Dose or percent noise exposure	TWA	Dose or percent noise exposure	TWA
81	88.5	116	90.1	350	99	700	104
82	88.6	117	90.1	360	99.2	710	104.1
83	88.7	118	90.2	370	99.4	720	104.2
84	88.7	119	91.3	380	99.6	730	104.3
85	88.8	120	91.3	390	99.8	740	104.4
86	88.9	125	91.6	400	100	750	104.5
87	89	130	91.9	410	100.2	760	104.6
88	89.1	135	92.2	420	100.4	770	104.7
89	89.2	140	92.4	430	100.5	780	104.8
90	89.2	145	92.7	440	100.7	790	104.9
91	89.3	150	92.9	450	100.8	800	105
92	89.4	155	93.2	460	101	810	105.1
93	89.5	160	93.4	470	101.2	820	105.2
94	89.6	165	93.6	480	101.3	830	105.3
95	89.6	170	93.8	490	101.5	840	105.4
96	89.7	175	94	500	101.6	850	105.4
97	89.8	180	94.2	510	101.8	860	105.5
98	89.9	185	94.4	520	101.9	870	105.6
99	89.9	190	94.6	530	102	880	105.7
100	90	195	94.8	540	102.2	890	105.8
						900	105.8
						910	105.9
						920	106
						930	106.1
						940	106.2
						950	106.2
						960	106.3
						970	106.4
						980	106.5
						990	106.5
						999	106.6

§ 1910.95 – 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 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 #1B1, #1B2 and #1B3. The NRR described below is a simplification of NIOSH method #1B2. The most complex method is NIOSH method #1B1, 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.

§ 1910.95 – 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 (±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 ±3 seconds.
(E) It must be possible at each test frequency to place a horizontal line segment parallel to the time axis on the audiogram, such that the audiometric tracing crosses the line segment at least six times at that test frequency. At each test frequency the threshold shall be the average of the midpoints of the tracing excursions.

§ 1910.95 – 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

§ 1910.95 – 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 ±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-39 earphones, dB**	**Sound level meter reading, dB**
500	11.5	81.5
1000	7	77
2000	9	79
3000	10	80
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**	**Sound level meter reading, dB**
500	13.5	83.5
1000	7.5	77.5
2000	11	81.0
3000	9.5	79.5
4000	10.5	80.5
6000	13.5	83.5

Appendix D – References

1) 29 CFR 1910.95 – Occupational Noise Exposure
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9) Sataloff, R.T., & Sataloff, J. (Eds.). (2006). Occupational Hearing Loss (3rd ed.). CRC Press. https://doi.org/10.1201/9781420015478
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