



Don H. Mahaffey Drilling Co.

***NOISE EXPOSURE & HEARING
PROTECTION***



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1 INTRODUCTION

It is the intent of Don H. Mahaffey Drilling Co. to equip employees with the necessary environment and equipment to adequately protect themselves from potential hearing loss. Don H. Mahaffey Drilling Co. has developed the following Hearing Protection program to guide the management in minimizing employee noise exposure and protecting employees exposed to noise, and ensuring compliance with Title 8, California Code of Regulations, Sections 5095 – 5100.

2 PROGRAM ADMINISTRATOR

Ashley Mahaffey Tullius has been designated as the administrator for this program and will be responsible for:

- a. Identifying work areas that could expose employees to potentially harmful noise levels;
- b. Control of employee noise exposures that equal or exceed permissible noise exposures as detailed in Table 4.2.2(A);
- c. Ensuring that employees use hearing protection when their noise exposure equals or exceeds permissible noise exposures;
- d. Ensuring that exposed employees receive training about noise and hearing protection;
- e. Arrange for oversight of audiometric testing; and
- f. Documentation of hearing loss prevention activities.

3 NOISE EXPOSURE AND HEARING LOSS PREVENTION, AN EXPLANATION OF

3.1 How Sound Affects Hearing

When sound waves enter the outer ear, the vibrations impact the eardrum and are transmitted to the middle and inner ear. Three small bones in the middle ear (malleus, incus, and stapes) amplify the vibrations and transmit them to the inner ear, containing the cochlea. The cochlea is filled with fluid and lined with cells with very fine hairs, which move the vibrations and convert the sound waves into nerve impulses, resulting in the sounds we hear. Exposure to loud noise can destroy these hair cells and cause hearing loss.

3.2 Categories of Noise

- 3.2.1 Wide Band – a noise that spans a wide range of frequencies, such as those in a manufacturing operation
- 3.2.2 Narrow Band – a limited band of sound frequencies, such as those resulting from the use of power tools
- 3.2.3 Impulse – a temporary sound that may or may not be repetitive

3.3 Sound Frequency and Decibels

- 3.3.1 Frequency is the rate or the number of times per second that a sound waves cycle from positive to negative to positive again. Frequency is measured in cycles per second, or hertz (Hz). Humans have a range of hearing from 20 Hz (low) to 20,000 Hz (high).
- 3.3.2 Decibels (dB) measure sound pressure. Like a temperature scale, the decibel scale goes below zero. The average person can hear sounds down to about 0 dB (the level of rustling leaves), and those with excellent hearing can hear sounds down to -15 dB. Hearing damage can occur when sound reaches 85 dB or stronger.

3.4 Noise as a Health Hazard

Noise is one of the most pervasive occupational health hazards today. Approximately nine million workers are exposed to noise levels that are potentially hazardous to their hearing. Fortunately, it has been shown that workplace-induced hearing loss can be substantially reduced through a proactive approach utilizing a well-rounded program consisting of:

- regular audiometric testing
- engineering controls
- personal hearing protective devices
- periodic review of program methods

3.5 Types of Hearing Loss

- 3.5.1 Permanent hearing loss can be a result of exposure to high levels of noise. Unfortunately, permanent hearing loss cannot be corrected.
- 3.5.2 Temporary hearing loss may be a result of short-term exposure to loud noises. While short-term symptoms such as ringing in the ears may subside within a few minutes or hours, repeated exposures to loud noise can lead to permanent hearing loss.

3.6 Side Effects of Noise-Induced Hearing Loss

The effects of noise-induced hearing loss can be profound, limiting an employee's ability to hear high-frequency sounds, understand speech, and seriously impairing their ability to communicate.

3.7 Additional Effects of Noise Exposure

In addition to the potential hearing loss resulting from exposure to high levels of workplace noise, the Occupational Safety and Health Administration warns that there is also:

- the potential for physical and psychological stress
- reduction in productivity
- interference with communication and concentration

- potential to contribute to workplace accidents and injuries by making it difficult to hear warning signals

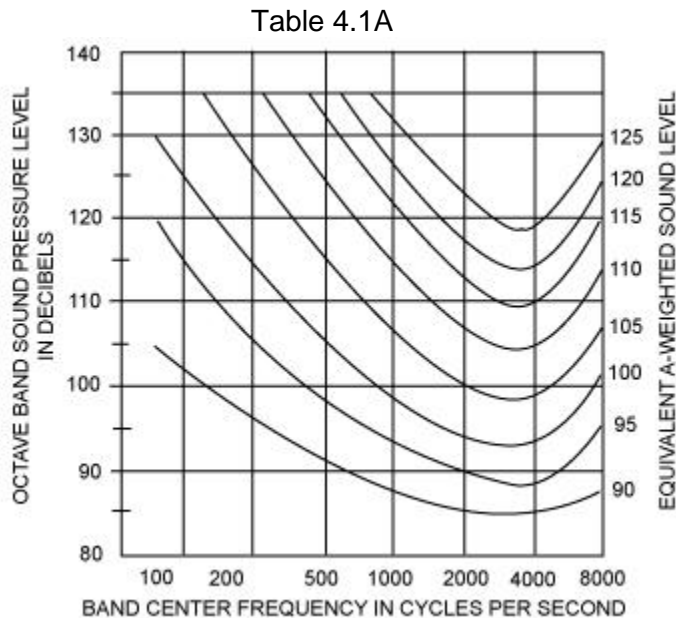
3.8 Noise Sources

Industrial machinery and processes are composed of various noise sources such as rotors, stators, gears, fans, vibrating panels, turbulent fluid flow, impact processes, electrical machines, internal combustion engines, etc. The mechanisms of noise generation depend on the particularly noisy operations and equipment, including crushing, riveting, blasting (quarries and mines), shake-out (foundries), punch presses, drop forges, drilling, lathes, pneumatic equipment (e.g., jackhammers, chipping hammers, etc.), tumbling barrels, plasma jets, cutting torches, sandblasting, electric furnaces, boiler making, machine tools for forming, dividing and metal cutting, such as punching, pressing and shearing, lathes, milling machines and grinders, as well as textile machines, beverage filling machines and print machines, pumps and compressors, drive units, hand-guided machines, self-propelled working machines, in-plant conveying systems, and transport vehicles.

4 WHEN HEARING PROTECTION IS REQUIRED

4.1 Determination by Octave Band Analysis

Protection against noise exposure effects will be provided when the sound levels exceed those shown in the table in Section 4.2.2(A) 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:



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 the table in Section 4.2.2(A).

4.2 Permissible Noise Exposures

- 4.2.1 When employees are subjected to sound exceeding those listed in Table 4.2.2(A), feasible administrative or engineering controls will be utilized. If such controls fail to reduce sound levels within the levels of Table 4.2.2(A), personal protective equipment will be provided and used to reduce sound levels within the levels of the table.
- 4.2.2 If the noise level variations involve maxima at intervals of 1 second or less, it is to be considered continuous.

Table 4.2.2(A)	
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 2 or more periods of noise exposure of different levels, their combined effect will 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 will 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 will not exceed 140 dB peak sound pressure level.

5 MONITORING

5.1 Monitoring Program

When information indicates that any employee's exposure may equal or exceed an 8-hour time-weighted average of 85 decibels, this program will be implemented.

- 5.1.1 The sampling strategy will be designed to identify employees for inclusion in the hearing conservation program and enable the proper selection of hearing protectors.

- 5.1.2 Where circumstances such as high worker mobility, significant variations in sound level, or a significant component of impulse noise make area monitoring generally inappropriate, representative personal sampling will be used to comply with this section's monitoring requirements unless it can be shown that area sampling produces equivalent results.

5.2 Noise Measurements

- 5.2.1 All continuous, intermittent and impulsive sound levels from 80 decibels to 130 decibels will be integrated into the noise measurements.
- 5.2.2 Instruments used to measure employee noise exposure will be calibrated to ensure measurement accuracy.

5.3 Monitoring Frequency

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

- a. Additional employees may be exposed at or above the action level; or
- b. The attenuation provided by hearing protectors being used by employees may be rendered inadequate to meet the requirements of Section 7.2.

5.4 Employee Notification

Each employee exposed at or above an 8-hour time-weighted average of 85 decibels will be notified of the results of the monitoring.

5.5 Observation of Monitoring

An opportunity to observe any noise measurements conducted pursuant to this program will be provided to affected employees or their representatives.

6 AUDIOMETRIC TESTING

Audiometric testing will be available to all employees whose exposures equal or exceed an 8-hour time-weighted average of 85 decibels at no cost to the employee.

6.1 Audiometric Test Requirements

- 6.1.1 Audiometric tests will 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 will be taken separately for each ear.
- 6.1.2 Audiometric tests will be conducted with audiometers (including microprocessor audiometers) that meet the specifications of and are maintained and used according to the American National Standard Specification for Audiometers S3.6-1969.
- 6.1.3 Pulsed-tone and self-recording audiometers, if used, will meet the requirements specified in Section 6.4.

6.1.4 Audiometric examinations will be administered in a room meeting the requirements listed in Section 6.3.

6.2 Audiometric Testing Personnel

Audiometric tests will 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.

6.3 Audiometric Test Rooms

Rooms used for audiometric testing will not have background sound pressure levels exceeding those in the table below 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 the Class II requirements of American National Standard Specification for Octave, Half-Octave and Third-Octave Band Filter Sets, S1.11-1971 (R1976).

Table 6.2(A) 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

6.4 Audiometric Measuring Instruments

6.4.1 In the event that pulsed-tone audiometers are used, they will have a tone on time of at least 200 milliseconds.

6.4.2 Self-recording audiometers will comply with the following requirements:

- The chart upon which the audiogram is traced will have lines at positions corresponding to all multiples of 10 dB hearing level within the intensity range spanned by the audiometer. The lines will be equally spaced and will be separated by at least 1/4 inch. Additional increments are optional. The audiogram pen tracings will not exceed 2 dB in width.
- It will be possible to set the stylus manually at the 10-dB increment lines for calibration purposes.
- The slewing rate for the audiometer attenuator will 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 will remain at each required test frequency for 30 seconds (+/- 3 seconds). The audiogram will be clearly marked at each change of frequency, and the actual frequency change of the audiometer will not deviate from the frequency boundaries marked on the audiogram by more than +/- 3 seconds.
- e. At each test frequency, it must be possible 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 will be the average of the midpoints of the tracing excursions.

6.5 Acoustic Calibration of Audiometers

- 6.5.1 The audiometer's functional operation will 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.
- 6.5.2 According to the procedures described in this section, audiometer calibration will be checked acoustically, at least annually. The equipment necessary to perform these measurements include:
 - a. A sound level meter,
 - b. Octave-band filter set, and
 - c. A National Bureau of Standards 9A coupler.

In making these measurements, the calibrating equipment's accuracy will be sufficient to determine that the audiometer is within the tolerances permitted by American Standard Specification for Audiometers, S3.6-1969.

- a. "Sound Pressure Output Check"
 - 1. Place the earphone coupler over the sound level meter microphone and place the earphone on the coupler.
 - 2. Set the audiometer's hearing threshold level (HTL) dial to 70 dB.
 - 3. Measure the tone's sound pressure level at each test frequency from 500 Hz through 6000 Hz for each earphone.
 - 4. At each frequency, the readout on the sound level meter should correspond to the levels in Table 6.11.2(A) or 6.11.2(B), as appropriate, for the type of earphone, in the column entitled "Sound Level Meter Reading."
- b. "Linearity Check"
 - 1. With the earphone in place, set the frequency to 1000 Hz and the HTL dial on the audiometer to 70 dB.
 - 2. 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.
 - 3. For each 10-dB decrement on the audiometer, the sound level meter should indicate a corresponding 10 dB decrease.
 - 4. This measurement may be made electrically with a voltmeter connected to the earphone terminals.
- c. "Tolerances"

When any of the measured sound levels deviate from the levels in Table 6.11.2(A) or Table 6.11.2(B) 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 6.11.2(A)		
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 6.11.2(B)		
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

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.

- 6.5.3 An exhaustive calibration will 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.

6.6 Baseline Audiogram

- 6.6.1 A valid baseline audiogram will be established within six months of an employee's first exposure at or above the action level against which subsequent audiograms can be compared.
- 6.6.2 Where mobile test vans are used to meet the audiometric testing obligation, a valid baseline audiogram will be obtained within one year of an employee's first exposure at or above the action level. Where baseline audiograms are obtained more than six months after the employee's first exposure at or above the action level, employees will wear hearing protectors for any period

exceeding six months after first exposure until the baseline audiogram is obtained.

- 6.6.3 Testing to establish a baseline audiogram will be preceded by at least fourteen hours without workplace noise exposure. Hearing protectors may be used as a substitute for the requirement that baseline audiograms be preceded by fourteen hours without exposure to workplace noise.
- 6.6.4 Employees will be notified of the need to avoid high levels of non-occupational noise exposure during the 14 hours immediately preceding the audiometric examination.

6.7 Evaluation of Audiogram

- 6.7.1 Each employee's annual audiogram will be compared to that employee's baseline audiogram to determine if the audiogram is valid and if a standard threshold shift as defined in Section 6.11 has occurred. This comparison may be done by a technician.
- 6.7.2 If the annual audiogram shows that an employee has suffered a standard threshold shift, a retest may be obtained within 30 days, and consider the results of the retest as the annual audiogram.
- 6.7.3 The audiologist, otolaryngologist, or physician will review problem audiograms and determine whether there is a need for further evaluation. The person performing this evaluation will be provided the following information:
 - a. A copy of the requirements for hearing conservation as outlined in this program;
 - 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 Section 6.3; and
 - d. Records of audiometer calibrations required by Section 6.5

6.8 Follow-up Procedures

- 6.8.1 If a comparison of the annual audiogram to the baseline audiogram indicates a standard threshold shift as defined in Section 6.11 has occurred, the employee will be informed of this fact in writing within 21 days of the determination.
- 6.8.2 Unless a physician determines that the standard threshold shift is not work-related or aggravated by occupational noise exposure, the following steps will be taken when a standard threshold shift occurs:
 - a. Employees not using hearing protectors will be fitted with hearing protectors, trained in their use and care, and required to use them;
 - b. Employees already using hearing protectors will be refitted and retrained in the use of hearing protectors and provided with hearing protectors offering greater attenuation, if necessary;

- c. The employee will be referred for a clinical audiological evaluation or an ontological examination, as appropriate, if additional testing is necessary or if it is suspected that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors; and
 - d. The employee is informed of the need for an ontological examination if a medical pathology of the ear that is unrelated to the use of hearing protectors is suspected.
- 6.8.3 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:
- a. The employee will be informed of the new audiometric interpretation; and
 - b. The use of hearing protectors may be discontinued for that employee.

6.9 Annual Audiogram

At least annually after obtaining the baseline audiogram, a new audiogram will be obtained for each employee exposed at or above an 8-hour time-weighted average of 85 decibels.

6.10 Revised Baseline Audiogram

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:

- a. The standard threshold shift revealed by the audiogram is persistent; or
- b. The hearing threshold shown in the annual audiogram indicates significant improvement over the baseline audiogram.

6.11 Standard Threshold Shift

6.11.1 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.

6.11.2 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 4: "Determination and Application of Age Correction to Audiograms."

7 HEARING PROTECTORS

7.1 General

7.1.1 Hearing protectors will be made available to all employees exposed to an 8-hour time-weighted average of 85 decibels or greater at no cost to the employees.

- 7.1.2 Hearing protectors will be worn by:
 - a. An employee who is required by Section 4.2.1 to wear personal protective equipment; and
 - b. Any employee who is exposed to an 8-hour time-weighted average of 85 decibels or greater, and who:
 - 1. Has not yet had a baseline audiogram established pursuant to Section 6.6; or
 - 2. Has experienced a standard threshold shift
- 7.1.3 Employees will be given the opportunity to select their hearing protectors from a variety of suitable hearing protectors provided by Don H. Mahaffey Drilling Co..
- 7.1.4 Proper initial fitting will be ensured, and the correct use of all hearing protectors will be supervised.
- 7.1.5 Hearing protectors will be replaced as necessary.

7.2 Hearing Protector Attenuation

- 7.2.1 Hearing protector attenuation will be evaluated for the specific noise environments in which the protector will be used. One of the evaluation methods described in Appendix 3: "Methods for Estimating the Adequacy of Hearing Protection Attenuation," will be used.
- 7.2.2 Hearing protectors will attenuate employee exposure at least to an 8-hour time-weighted average of 90 decibels as required by Section 4.2.
- 7.2.3 For employees who have experienced a standard threshold shift, hearing protectors will attenuate employee exposure to an 8-hour time-weighted average of 85 decibels or below.
- 7.2.4 The adequacy of hearing protector attenuation will be re-evaluated whenever employee noise exposures increase to the extent that the hearing protectors provided may no longer provide adequate attenuation. More effective hearing protectors will be provided when necessary.

8 TRAINING

8.1 General

- 8.1.1 Each employee exposed to noise at or above an 8-hour time-weighted average of 85 decibels will be trained in accordance with the requirements of this program.
- 8.1.2 Employee participation in this program is mandatory.

8.2 Training Frequency

The training program will be repeated annually for all employees who are exposed to action-level noise. Information provided in the training program will be updated to be consistent with changes in protective equipment and work processes.

8.3 Training Topics

Each employee will be informed of the following:

- a. The effects of noise on hearing;
- b. The purpose of hearing protectors (the advantages, disadvantages, and attenuation of various types);
- c. Instructions on selection, fitting, use, and care of hearing protectors;
- d. The purpose of audiometric testing; and
- e. An explanation of the test procedures.

8.4 Access to Information and Training Materials

- 8.4.1 This program has been written to comply with Article 105 of Subchapter 7 of the Cal/OSHA standards. Copies of this program will be made available to affected employees or their representatives. A copy will also be posted in the workplace.
- 8.4.2 Any information materials pertaining to this program that is supplied to Don H. Mahaffey Drilling Co. by the Chief will be provided to affected employees.
- 8.4.3 All materials related to the Noise Exposure and Hearing Protection training and education program will be provided, upon request, to the Chief of the Division and the Director, National Institute of Occupational Safety and Health.

9 RECORDKEEPING

9.1 Exposure Measurements

An accurate record of all employee exposure measurements required by Section 5 will be maintained.

9.2 Audiometric Tests

- 9.2.1 Audiometric test records obtained pursuant to Section 6 will be retained. This record will 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. Employees' most recent noise exposure assessment.

- 9.2.2 Accurate records of the measurements of the background sound pressure levels in audiometric test rooms will be maintained.

9.3 Record Retention

- 9.3.1 Noise exposure measurement records will be retained for two years.
- 9.3.2 Audiometric test records will be retained for the duration of the affected employee's employment.

9.4 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 any authorized representative of the Chief of the Division. The provisions of California Code of Regulations, Title 8, Sections 3204(a)-(g) and (h) apply to access to records.

9.5 Transfer of Records

In the event that Don H. Mahaffey Drilling Co. ceases to do business, all records required to be maintained by this program will be transferred to the successor employer, and the successor employer will retain them for the remainder of the period prescribed in Section 9.3.

APPENDIX 1 – DEFINITIONS

A-weighted – An Adjustment to sound level measurements that reflect the sensitivity of the human ear. Used for evaluating continuous or average noise levels.

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

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, Hearing, and Language Association, or the American Academy of Audiology, and is licensed by the state board of examiners.

Baseline audiogram – The audiogram against which future audiograms are compared. The baseline audiogram is collected when an employee is first assigned to work with noise exposure. The baseline audiogram may be revised if persistent standard threshold shift (STS) of improvement is found.

Continuous noise – Noise with peaks spaced no more than one second apart. Continuous noise is measured using sound level meters and noise dosimeters with the slow response setting.

Criterion sound level – A sound level of 90 decibels. An 8-hour exposure to constant 90 dBA noise is a 100% noise dose exposure.

C-weighted – An adjustment to sound level measurements that evenly represents frequencies within the range of human hearing. Used for evaluating impact or impulse noise.

Decibel (dB) – Unit of measurement of sound level. A-weighting, adjusting for the sensitivity of the human ear, is indicated as "dBA." C-weighting, an even reading across the frequencies of human hearing, is indicated as "dBC."

Hertz (Hz) – Unit of measurement of frequency, numerically equal to cycles per second.

Impulsive or impact noise – Noise levels which involve maxima at intervals greater than one second. Impulse and impact noise is measured using the fast response setting on a sound level meter.

Medical pathology – A disorder or disease. For purposes of this program, 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.

Occupational hearing loss – A reduction in the ability of an individual to hear either caused or contributed to by exposure in the work environment

Otolaryngologist – A physician specializing in diagnosis and treatment of disorders of the ear, nose, and throat

Qualified reviewer – An audiologist, otolaryngologist, or other qualified physician who has experience and training in evaluating occupational audiograms

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

Slow response – A setting for sound level meters and dosimeters in which the meter does not register events of less than about one second. Used for evaluating continuous and average noise levels.

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 micro pascals. Unit: decibels (dB). For use with this program, SLOW time response, in accordance with ANSI S1.4-1971 (R1976), is required.

Sound level meter – An instrument that measures sound levels

Standard threshold shift (STS) – A hearing level change, relative to the baseline audiogram, of an average of 10 dB or more at 2000, 3000, and 4000 Hz in either ear

Temporary threshold shift – A hearing level change that improves: A temporary threshold shift may occur with exposure to noise, and hearing will return to normal within a few days. Temporary threshold shifts can be indicators of exposures that lead to permanent hearing loss.

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.

APPENDIX 2 – NOISE EXPOSURE COMPUTATION

1 Computation of Employee Noise Exposure

1.1 Noise dose is computed using the table below:

- a. 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 workday, in hours, and T is the reference duration corresponding to the measured sound level (L) as given in Table A2-1.3(A) or by the formula shown as a footnote to that table.

- b. When the work shift noise exposure is composed of 2 or more periods of noise at different levels, the total noise dose over the workday is given by:

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

Where C(n) indicated the total time of exposure at a specific noise level and T(n) indicates the reference duration for that level as given by Table A2-1.3(A).

1.2 The 8-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 8-hour work shift with the noise level constant over the entire shift, the TWA is equal to the measured sound level.

1.3 A table relating dose and TWA is given in Section 2 of this Appendix.

Table A2-1.3(A)	
A-weighted sound level, L (decibel)	Reference duration, T (hour)
80	32.0
81	27.9
82	24.3
83	21.1
84	18.4
85	16.0
86	13.9
87	12.1
88	10.6
89	9.2
90	8.0
91	7.0
92	6.1
93	5.3
94	4.6
95	4.0

96	3.5
97	3.0
98	2.6
99	2.3
100	2.0
101	1.7
102	1.5
103	1.3
104	1.1
105	1.0
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 (T) is computed by:

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

Where L is the measured A-weighted sound level.

2 CONVERSION BETWEEN "DOSE" AND "8-HOUR TIME-WEIGHTED AVERAGE"

2.1 Sound Level

- 2.1.1 Compliance with Sections 4 through 8 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 audio dosimeter 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)
- 2.1.2 In order to convert the reading of a dosimeter into TWA, see Table A2-1.3(A) below. This table applies to dosimeters that are set by the manufacturer to calculate dose or percent exposure according to the relationships in Table A2-1.3(A). For example, a dose of 91% over an 8-hour day results in a TWA of 89.3 dB, and a dose of 50% corresponds to a TWA of 85 dB.
- 2.1.3 If the dose, as read on the dosimeter, is less than or greater than the values found in Table A2-1.3(A), the TWA may be calculated by using the formula:

$$\text{TWA} = 16.61 \log(10) (D/100) + 90$$

Where: TWA = 8-hour time-weighted average sound level; and,
D = accumulated dose in percent exposure

Table A2-2.1.3(A) Conversion from "Percent Noise Exposure" or "Dose" to "8-Hour Time-Weighted Average Sound Level" (TWA)	
Dose or % 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	91.3
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
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	103.7
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 3 – METHODS FOR ESTIMATING THE ADEQUACY OF HEARING PROTECTOR ATTENUATION

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. One of the following methods by which to estimate the adequacy of hearing protector attenuation will be chosen.

1. The most convenient method is the Noise Reduction Rating (NRR) developed by the Environmental Protection Agency (EPA). According to the 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 noise measuring instruments.
2. Instead of using the NRR, the adequacy of hearing protector attenuation may be evaluated by using one of the 3 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. A sufficient number of measurements will be taken in order to achieve a representative sample for each time segment.

NOTE: 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 will be used:

- A. When using a dosimeter that is capable of C-weighted measurements:
 1. Obtain the employee's C-weighted dose for the entire work shift and convert to TWA (see Appendix 2).
 2. Subtract the NRR from the C-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.
- B. When using a dosimeter that is not capable of C-weighted measurements, the following method may be used:
 1. Convert the A-weighted dose to TWA (See Appendix 2).
 2. Subtract 7 dB from the NRR.
 3. Subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.
- C. When using a sound level meter set to the A-weighting network:
 1. Obtain the employee's A-weighted TWA.
 2. 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.

- D. When using a sound level meter set on the C-weighting network:
 - 1. Obtain a representative sample of the C-weighted sound levels in the employee's environment.
 - 2. Subtract the NRR from the C-weighted average sound level to obtain the estimated A-weighted TWA under the ear protector.
- E. When using area monitoring procedures and a sound level meter set to the A-weighting network:
 - 1. Obtain a representative sound level for the area in question.
 - 2. Subtract 7 dB from the NRR and subtract the remainder from the A-weighted sound level for that area.
- F. When using area monitoring procedures and a sound level meter set to the C-weighting network:
 - 1. Obtain a representative sound level for the area in question.
 - 2. Subtract the NRR from the C-weighted sound level for that area.

APPENDIX 4 – DETERMINATION AND APPLICATION OF AGE CORRECTION AUDIOGRAMS

As permitted by subsection 6.11.2 of this program, increases in an employee's hearing thresholds, as evidenced by an audiogram taken subsequent to a baseline audiogram, may be adjusted (lowered) for presbycusis (hearing loss due to aging). The applicable correction values at various ages and sound frequencies are included in Table F. Chosen adjustments to an employee's audiogram pursuant to subsection 6.11.2 will follow the procedures described below.

- a. Obtain from Table F the age correction values at each audiometric test frequency of interest (the hearing losses at 2000, 3000, and 4000Hz are relevant to the determination of whether a standard threshold shift, as defined by subsection 6.11.1 may exist for the employee by:
 1. Finding the age at which the most recent audiogram was taken and recording the corresponding age correction values; and
 2. Finding the age at which the baseline audiogram was taken and recording the corresponding age correction values.
- b. Subtract the values found in a(2) from those found in a(1). (The remainders from these subtractions represent the values (in decibels) that may be attributed to aging and are the values by which the most recent audiogram may be adjusted at the respective audiometric test frequencies.)
- c. Subtract the values found in b from the hearing threshold values of the most recent audiogram.

When the adjustment of an audiogram for hearing loss due to aging is performed for the purpose of determining whether a standard threshold shift has occurred, the above-described calculations may be restricted to 2000, 3000, and 4000 Hz frequencies. If the average of the hearing threshold values at 2000, 3000, and 4000 Hz found in step c, above, is equal to or greater than 10, then the employee has exhibited a standard threshold shift, and the various provisions of subsection 6.11 as well as certain other requirements such as subsections 7.1.2(b)(2) and 7.2.3 will be complied with.

TABLE F										
Age Correction Values in Decibels for Males (M) and Females (F)										
Age	Audiometric Test Frequencies (Hz)									
	1000		2000		3000		4000		6000	
	M	F	M	F	M	F	M	F	M	F
20 years or younger	5	7	3	4	4	3	5	3	8	6
21	5	7	3	4	4	4	5	3	8	6
22	5	7	3	4	4	4	5	4	8	6
23	5	7	3	5	4	4	6	4	9	7
24	5	7	3	5	5	4	6	4	9	7
25	5	8	3	5	5	4	7	4	10	7
26	5	8	4	5	5	5	7	4	10	8
27	5	8	4	5	6	5	7	5	11	8
28	6	8	4	5	6	5	8	5	11	8
29	6	8	4	5	6	5	8	5	12	9
30	6	8	4	6	6	5	9	5	12	9
31	6	8	4	6	7	6	9	5	13	9
32	6	9	5	6	7	6	10	6	14	10
33	6	9	5	6	7	6	10	6	14	10

TABLE F										
Age Correction Values in Decibels for Males (M) and Females (F)										
Age	Audiometric Test Frequencies (Hz)									
	1000		2000		3000		4000		6000	
	M	F	M	F	M	F	M	F	M	F
34	6	9	5	6	8	6	11	6	15	10
35	7	9	5	6	8	7	11	7	15	11
36	7	9	5	7	9	7	12	7	16	11
37	7	9	6	7	9	7	12	7	17	12
38	7	10	6	7	9	7	13	7	17	12
39	7	10	6	7	8	14	8	18	18	127
40	7	10	6	7	10	8	14	8	19	13
41	7	10	6	8	10	8	14	8	20	13
42	8	10	7	8	11	9	16	9	20	13
43	8	11	7	8	12	9	16	9	21	14
44	8	11	7	8	12	9	17	9	22	14
45	8	11	7	8	13	10	18	10	23	15
46	8	11	8	9	13	10	19	10	24	15
47	8	11	8	9	14	10	19	11	24	16
48	9	12	8	9	14	11	20	11	25	16
49	9	12	9	9	15	11	21	11	26	16
50	9	12	9	10	16	11	22	12	27	17
51	9	12	9	10	16	12	23	12	28	17
52	9	12	10	10	17	12	24	13	29	18
53	9	13	10	10	18	13	25	13	30	18
54	10	13	10	11	18	13	26	14	31	19
55	10	13	11	11	19	14	27	14	32	19
56	10	13	11	11	20	14	28	15	34	20
57	10	13	11	11	21	15	29	15	35	20
58	10	14	12	12	22	15	31	16	36	21
59	11	14	12	12	22	16	32	16	37	21
60 or older	11	14	13	12	23	16	33	17	38	22