



Washington State Department of  
**Labor & Industries**  
*Division of Occupational Safety and Health*

# Hearing Loss Prevention (Noise)

**Chapter 296-817 WAC**

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Division of Occupational Safety and Health



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**Standards Update**  
**Chapter 296-817 WAC**  
**Safety Standards to Hearing Loss Prevention (Noise)**  
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The Department of Labor and Industries has rewritten and reorganized for clarity and ease of use the safety standards for Hearing Conservation. Hearing Conservation rules, in chapter 296-62 WAC, Part K, were rewritten and adopted as chapter 296-817 WAC, Hearing Loss Prevention (Noise). Please discard WAC 296-62-09015 through 296-62-09055.

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- Physical address: 7273 Linderson Way, Tumwater, WA 98501-5414, located off I-5 Exit 101 south of Tumwater.
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**Chapter 296-817 WAC  
HEARING LOSS PREVENTION (NOISE)**

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**WAC 296-817-100 Scope.**

The purpose of this chapter is to:

- Prevent employee hearing loss by minimizing employee noise exposures  
AND
- Make sure employees exposed to noise are protected.

These goals are accomplished by:

- Measuring and computing the employee noise exposure from all equipment and machinery in the workplace, as well as any other noise sources in the work area
- Protecting employees from noise exposure by using feasible noise controls
- Making sure employees use hearing protection, if you can't feasibly control the noise
- Training employees about hearing loss prevention
- Evaluating your hearing loss prevention efforts by tracking employee hearing or periodically reviewing controls and protection
- Making appropriate corrections to your program.

*Reference:*

Table 1 will help you determine the hearing loss prevention requirements for your workplace. For the specific requirements associated with Noise Evaluation Criteria, see WAC 296-817-30010 of this chapter.

<b>Table 1 Noise Evaluation Criteria</b>		
<b>Criteria</b>	<b>Description</b>	<b>Requirements</b>
85 dBA TWA <sub>8</sub>	Full-day employee noise exposure dose. If you have one or more employees whose exposure equals or exceeds this level, you must have a hearing loss prevention program	<ul style="list-style-type: none"> <li>– Hearing protection</li> <li>– Training</li> <li>– Audiometric testing</li> </ul>
90 dBA TWA <sub>8</sub>	Full-day employee noise exposure dose. If you have one or more employees whose exposure equals or exceeds this level, you must reduce employee noise exposures in the workplace	<ul style="list-style-type: none"> <li>– Noise controls AND</li> <li>– Hearing protection</li> <li>– Training</li> <li>– Audiometric testing</li> </ul>
115 dBA measured using slow response	Extreme noise level (greater than one second in duration)	<ul style="list-style-type: none"> <li>– Hearing protection</li> <li>– Signs posted in work areas warning of exposure</li> </ul>
140 dBC measured using fast response	Extreme impulse or impact noise (less than one second in duration)	Hearing protection

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-100, filed 05/19/03, effective 08/01/03.]

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**HEARING LOSS PREVENTION PROGRAM**
**WAC 296-817-200 Summary.****Your responsibility:**

To prevent employee hearing loss by minimizing, and providing protection from, noise exposures.

**You must:**

Conduct employee noise exposure monitoring

*WAC 296-817-20005*

Control employee noise exposures that equal or exceed 90 dBA TWA<sub>8</sub>

*WAC 296-817-20010*

Make sure employees use hearing protection when their noise exposure equals or exceed 85 dBA TWA<sub>8</sub>

*WAC 296-817-20015*

Make sure exposed employees receive training about noise and hearing protection

*WAC 296-817-20020*

Make sure warning signs are posted for areas with noise levels that equal or exceed 115 dBA

*WAC 296-817-20025*

Arrange for oversight of audiometric testing

*WAC 296-817-20030*

Identify and correct deficiencies in your hearing loss prevention program

*WAC 296-817-20035*

Document your hearing loss prevention activities

*WAC 296-817-20040.*

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-200, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-20005 Conduct employee noise exposure monitoring.****You must:**

- Conduct employee noise exposure monitoring to determine the employee's actual exposure when reasonable information indicates that any employee's exposure may equal or exceed 85 dBA TWA<sub>8</sub>.

*Note:*

- Representative monitoring may be used where several employees perform the same tasks in substantially similar conditions
- Examples of information or situations that can indicate exposures which equal or exceed 85 dBA TWA<sub>8</sub>, include:
  - Noise in the workplace that interferes with people speaking, even at close range
  - Information from the manufacturer of equipment you use in the workplace that indicates high noise levels for machines in use
  - Reports from employees of ringing in their ears or temporary hearing loss
  - Warning signals or alarms that are difficult to hear
  - Work near abrasive blasting or jack hammering operations
  - Use of tools and equipment such as the following:
    - Heavy equipment or machinery
    - Fuel-powered hand tools
    - Compressed air-driven tools or equipment in frequent use
    - Power saws, grinders or chippers
    - Powder-actuated tools.

**You must:**

- Follow applicable guidance in WAC 296-817-300 when conducting noise exposure monitoring
- Make sure your sampling for noise exposure monitoring identifies:
  - All employees whose exposure equals or exceeds the following:
    - 85 dBA TWA<sub>8</sub> (noise dosimetry, providing an average exposure over an 8-hour time period)
    - 115 dBA (slow response sound level meter, identifying short-term noise exposures)
    - 140 dBC (fast response sound level meter, identifying almost instantaneous noise exposures).
  - Exposure levels for selection of hearing protection.
- Provide exposed employees and their representatives with an opportunity to observe any measurements of employee noise exposure that are conducted
- Notify each employee whose exposure equals or exceeds 85 dBA TWA<sub>8</sub> of the monitoring results within 5 working days of when you receive the results
- Conduct additional noise monitoring whenever a change in production, process, equipment or controls, may reasonably be expected to result in:
  - Additional employees whose exposure equals or exceeds 85 dBA TWA<sub>8</sub>
  - Employees exposed to higher level of noise requiring more effective hearing protection

*Note:* Conditions that may be expected to increase exposure include:

- Adding machinery to the work area
- Increasing production rates
- Removal or deterioration of noise control devices
- Increased use of noisy equipment
- Change in work schedule
- Change of job duties.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-20005, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-20010 Control employee noise exposures that equal or exceed 90 dBA TWA<sub>8</sub>.****Important:**

Hearing protection provides a barrier to noise and protects employees but isn't considered a control of the noise hazard. Separate requirements apply to hearing protection and are found in WAC 296-817-20015.

**You must:**

- Reduce employee noise exposure, using feasible controls, wherever exposure equals or exceeds 90 dBA TWA<sub>8</sub>.

*Note:*

- Once noise exposures are brought below 90 dBA TWA<sub>8</sub>, no further reduction is required. However, further reduction of noise may reduce the need for other hearing loss prevention requirements
- Controls that eliminate noise at the source or establish a permanent barrier to noise are typically more reliable. For example:
  - Replacing noisy equipment with quiet equipment
  - Using silencers and mufflers
  - Installing enclosures
  - Damping noisy equipment and parts.
- Other controls and work practices may also be useful for reducing noise exposures. Examples include:

- Employee rotation
- Limiting use of noisy equipment
- Rescheduling work.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-20010, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-20015 Make sure employees use hearing protection when their noise exposure equals or exceeds 85 dBA TWA<sub>8</sub>.**

**You must:**

- Make sure employees wear hearing protectors that will provide sufficient protection when exposure equals or exceeds:
  - Eighty-five dBA TWA<sub>8</sub> (noise dosimetry, providing an average exposure over an 8-hour time -period)
  - One hundred and fifteen dBA (slow response sound level meter, identifying short-term noise exposures)
  - One hundred and forty dBC (fast response sound level meter, identifying almost instantaneous noise exposures).
- Provide employees with an appropriate selection of hearing protectors:
  - The selection must include at least 2 distinct types (such as molded earplugs, foam earplugs, custom-molded earplugs, earcaps, or earmuffs) for each exposed employee and must be sufficient to cover:
    - Different levels of hearing protection needed in order to reduce all employee exposures to a level below 85 dBA TWA<sub>8</sub>
    - Different sizes
    - Different working conditions.
  - Consider requests of the employees regarding:
    - Physical comfort
    - Environmental conditions
    - Medical needs
    - Communication requirements.

*Note:* Hearing protector selection should include earplugs, earcaps and earmuffs.

**You must:**

- Provide hearing protection at no cost to employees
- Supervise employees to make sure that hearing protection is used correctly
- Make sure hearing protectors are:
  - Properly chosen for fit
  - Replaced as necessary.

- Make sure all hearing protection is sufficient to reduce the employee's equivalent 8-hour noise exposure to 85 dBA or less. When using the A-weighted exposure measurements, reported as "dBA TWA<sub>8</sub>," the reduction in noise exposure by hearing protectors is given by Table 2:

<b>Table 2</b>	
<b>Effective Protection of Hearing Protectors</b>	
<b>Type of hearing protection</b>	<b>Effective protection</b>
Single hearing protection (earplugs, earcaps or earmuffs)	7 dB less than the manufacturer assigned noise reduction rating (NRR); for example, earplugs with an NRR of 20 dB are considered to reduce employee exposures of 95 dBA TWA <sub>8</sub> to 82 dBA TWA <sub>8</sub>
Dual hearing protection (earplug and earmuff worn together)	2dB less than the higher NRR of the two protectors; for example, earplugs with an NRR of 20 dB and earmuffs with an NRR of 12 dB are considered to reduce employee exposures of 100 dBA TWA <sub>8</sub> to 82 dBA TWA <sub>8</sub>

- In addition to protection based on daily noise dose, make sure hearing protection has an NRR of at least 20 dB when exposures involve noise that equals or exceeds 115 dBA (slow response sound level meter) or 140 dBC (fast response sound level meter).

**Note:** You may also evaluate hearing protection by using the other methods given in the NIOSH *Compendium of Hearing Protection* (NIOSH Publication No. 95-105). These methods require additional monitoring and are more complex, but provide a more thorough evaluation of protection. This may be useful in cases where communication is critical or for evaluating hearing protection for employees with hearing impairment.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-20015, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-20020 Make sure exposed employees receive training about noise and hearing protection.**

**You must:**

- Train each employee whose noise exposure equals or exceeds 85 dBA TWA<sub>8</sub>
- Provide training when an employee is first assigned to a position involving noise exposure that equals or exceeds 85 dBA TWA<sub>8</sub> **and** at least annually after that
- Update information provided in the training program to be consistent with changes in controls, hearing protectors and work processes
- Make sure your noise and hearing protection training includes:
  - The effects of noise on hearing (including both occupational and nonoccupational exposures)
  - Noise controls used in your workplace
  - The purpose of hearing protectors: The advantages, disadvantages, and attenuation of various types
  - Instructions about selecting, fitting, using, and caring for hearing protection
  - The purpose and procedures for program evaluation including audiometric testing and hearing protection auditing when you choose to rely upon auditing (see WAC 296-817-500)
  - The employees' right to access records kept by the employer.
- Maintain a written program describing initial and refresher training.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 09-156-145 (Order 09-04), § 296-817-20020, filed 07/21/09, effective 09/01/09.  
Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-20020, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-20025 Make sure warning signs are posted for areas where noise levels equal or exceed 115 dBA.****You must:**

- Make sure warning signs are posted at the entrances or boundaries of all well-defined work areas where employees may be exposed to noise that equals or exceeds 115 dBA (measured using a sound level meter with slow response).
  - Warning signs must clearly indicate that the area is a high noise area and that hearing protectors are required.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-20025, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-20030 Arrange for oversight of audiometric testing.****You must:**

- Make sure audiometric testing as described by WAC 296-817-400 is supervised and reviewed by one of the following licensed or certified individuals:
  - An audiologist
  - An otolaryngologist
  - Another qualified physician.
- Make sure audiograms are conducted by one of the above individuals or by a technician certified by the Council of Accreditation in Occupational Hearing Conservation (CAOHC) and responsible to a qualified reviewer.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-20030, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-20035 Identify and correct deficiencies in your hearing loss prevention program.****You must:**

- Use audiometric testing to identify hearing loss, which may indicate program deficiencies
- Take appropriate actions when deficiencies are found with your program.
  - A deficiency may be indicated when:
    - Any employee experiences measurable hearing loss indicated by a standard threshold shift
    - OR**
    - Any employee isn't wearing appropriate hearing protection during an audit when auditing is used in place of baseline audiograms for short-term employees (see WAC 296-817-500, Option to audiometric testing).

*Note:* A standard threshold shift or audit deficiency doesn't necessarily indicate that a significant hearing loss has occurred. These criteria are intended to help identify where there may be flaws in your hearing loss prevention program that can be fixed before permanent hearing loss occurs.

There are additional statistical tools and tests that may be used to improve the effectiveness of your program. Staff conducting audiometric testing and auditing may be able to suggest additional ways to improve your hearing loss prevention program and tailor it to your worksite.

**You must:**

- Evaluate the following, at a minimum, when responding to a standard threshold shift:
  - Employee noise exposure measurements
  - Noise controls in the work area
  - The selection of hearing protection available and refit employees as necessary
  - Employee training on noise and the use of hearing protection and conduct additional training as necessary.

- *Reference:* You may use the option of auditing hearing protection (see WAC 296-817-500) for employees hired or transferred to jobs with noise exposure for less than one year. You may also use audiograms provided by a third-party hearing loss prevention program in some circumstances. Details of these program options are found in WAC 296-817-500, Options to audiometric testing.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-20035, filed 05/19/03, effective 08/01/03.]

### **WAC 296-817-20040 Document your hearing loss prevention activities.**

#### **You must:**

- Create and retain records documenting noise exposures. Include, at a minimum:
  - Exposure measurements required by this chapter for at least 2 years and for as long as you rely upon them to determine employee exposure
  - Audiometric test records for the duration of employment for the affected employees
  - Hearing protection audits, if you choose to rely upon them, for the duration of employment of the affected employees.

#### *Note:*

- You need to keep as complete a record as possible. Records developed under previous rules or in other jurisdictions need to be kept, even when they do not fulfill the full requirements of this chapter. Similarly, records found to have errors in collection or processing need to be kept if they provide an indication of employee exposure or medical condition not found in other records
- You may want to consider your other business needs, such as worker's compensation claims management, before discarding these records.

*Reference:* You need to follow additional requirements for records considered employee exposure or medical records. See chapter 296-62 WAC, Part B, Access to records for requirements for access to records, employee rights, and transfer of records.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-20040, filed 05/19/03, effective 08/01/03.]

## **NOISE MEASUREMENT AND COMPUTATION**

### **WAC 296-817-300 Summary.**

#### **Your responsibility:**

Conduct noise monitoring or measurement to evaluate employee exposures in your workplace.

#### **You must:**

Make sure that noise-measuring equipment meets recognized standards  
*WAC 296-817-30005*

Measure employee noise exposure  
*WAC 296-817-30010*

Use these equations when estimating full-day noise exposure from sound level measurements  
*WAC 296-817-30015.*

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-300, filed 05/19/03, effective 08/01/03.]

### **WAC 296-817-30005 Make sure that noise-measuring equipment meets recognized standards.**

#### **You must:**

- Make sure that noise dosimetry equipment meets these specifications:
  - Dosimeters must be equipment class 2AS-90/80-5 of the American National Rule Specification for Personal Noise Dosimeters, ANSI S1.25-1991, such dosimeters are normally marked "Type 2."

*Note:* Make sure any dosimeter you use is Type 2 equipment that:

- Uses slow integration and A-weighting of sound levels.
- Has the **criterion level** set to 90 dB, so the dosimeter will report a constant 8-hour exposure at 90

dB(A) as a 100% dose.

- Has the **threshold level** set at 80 dB, so the dosimeter will register all noise above 80 dB.
- Uses a 5 dB **exchange rate** for averaging of noise levels over the sample period.

**You must:**

- Make sure that sound level meters meet these specifications:
  - American National Standard Specification for Sound Level Meters, S1.4-1984, Type 2 requirements for sound level meters, such sound level meters are normally marked “Type 2.”
    - For continuous noise measurements, the meter must be capable of measuring A-weighted sound levels with slow response
    - For impulse or impact noise measurements, the meter must be capable of indicating maximum C-weighted sound level measurements with fast response.
- Calibrate dosimeters and sound level meters used to monitor employee noise exposure:
  - Before and after each day's use
  - **AND**
  - Following the instrument manufacturer's calibration instructions.

*Note:*

- You may conduct dosimetry using an exchange rate less than 5 dB and compare the results directly to the noise evaluation criteria in Table 1
- For measuring impulse and impact noise you may also use a sound level meter set to measure maximum impulse C-weighted sound levels or peak C-weighted sound levels.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-30005, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-30010 Measure employee noise exposure.**

**Important:**

A noise dosimeter is the basis for determining total daily noise exposure for employees. However, where you have constant noise levels, you may estimate employee noise exposure using measurements from a sound level meter. Calculation of the employee noise exposure must be consistent with WAC 296-817-30015.

**You must:**

- Include all:
  - Workplace noise from equipment and machinery in use
  - Other noise from sources necessary to perform the work
  - Noise outside the control of the exposed employees.
- Use a noise dosimeter when necessary to measure employee noise dose
- Use a sound level meter to evaluate continuous and impulse noise levels
- Identify all employees whose exposures equal or exceed the Noise Evaluation Criteria as follows:

Noise Evaluation Criteria		
Criteria	Description	Requirements
85 dBA TWA <sub>8</sub>	Full-day employee noise exposure dose. If you have one or more employees whose exposure equals or exceeds this level, you must have a hearing loss prevention program	<ul style="list-style-type: none"> <li>– Hearing protection</li> <li>– Training</li> <li>– Audiometric testing</li> </ul>
90 dBA TWA <sub>8</sub>	Full-day employee noise exposure dose. If you have one or more employees whose exposure equals or exceeds this level, you must reduce employee noise exposures in the workplace	Noise controls (in addition to the requirements for 85 dBA TWA <sub>8</sub> )
115 dBA measured using slow response	Extreme noise level (greater than one second in duration)	<ul style="list-style-type: none"> <li>– Hearing protection</li> <li>– Signs posted in work areas warning of exposure</li> </ul>
140 dBC measured using fast response	Extreme impulse or impact noise (less than one second in duration)	Hearing protection

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-30010, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-30015 Use these equations when estimating full-day noise exposure from sound level measurements.**

**You must:**

- Compute employee's full-day noise exposure by using the appropriate equations from Table 3 "Noise Dose Computation" **when** using a sound level meter to estimate noise dose.

Table 3 Noise Dose Computation	
Description	Equation
Compute the noise dose based on several time periods of constant noise during the shift	The total noise dose over the work day, as a percentage, is given by the following equation where C <sub>n</sub> indicates the total time of exposure at a specific noise level, and T <sub>n</sub> indicates the reference duration for that level. $D = 100 \cdot ((C_1/T_1) + (C_2/T_2) + (C_3/T_3) + \dots + (C_n/T_n))$
The reference duration is equal to the time of exposure to continuous noise at a specific sound level that will result in a one hundred percent dose	The reference duration, T, for sound level, L, is given in hours by the equation: $T = 8 / (2^{(L - 90)/5})$
Given a noise dose as a percentage, compute the equivalent eight-hour time weighted average noise level	The equivalent eight-hour time weighted average, TWA <sub>8</sub> , is computed from the dose, D, by the equation: $TWA_8 = 16.61 \cdot \log_{10}(D/100) + 90$

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-30015, filed 05/19/03, effective 08/01/03.]

## AUDIOMETRIC TESTING

### WAC 296-817-400 Summary

#### Your responsibility:

To conduct audiometric testing of employees exposed to noise to make sure that their hearing protection is effective.

#### You must:

Provide audiometric testing at no cost to employees

*WAC 296-817-40005*

Establish a baseline audiogram for each exposed employee

*WAC 296-817-40010*

Conduct annual audiograms

*WAC 296-817-40015*

Review audiograms that indicate a standard threshold shift

*WAC 296-817-40020*

Keep the baseline audiogram without revision, unless annual audiograms indicate a persistent threshold shift or a significant improvement in hearing

*WAC 296-817-40025*

Make sure a record is kept of audiometric tests

*WAC 296-817-40030*

Make sure audiometric testing equipment meets these requirements

*WAC 296-817-40035.*

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-400, filed 05/19/03, effective 08/01/03.]

#### **WAC 296-817-40005 Provide audiometric testing at no cost to employees.**

#### You must:

- Provide audiograms, including any required travel or necessary additional examinations or testing, at no cost to exposed employees.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-40005, filed 05/19/03, effective 08/01/03.]

#### **WAC 296-817-40010 Establish a baseline audiogram for each exposed employee.**

#### You must:

- Conduct a baseline audiogram when an employee is first assigned to work involving noise exposures that equal or exceed 85 dBA TWA<sub>8</sub>.
  - Make sure this audiogram is completed no more than 180 days after the employee is first assigned
  - OR**
  - Make sure employee is covered by a hearing protection audit program (as described by WAC 296-817-500 and available as an alternative only for employees hired for less than one year).

*Note:* Employers who utilize mobile test units are allowed up to one year to obtain a valid baseline audiogram for each exposed employee. The employees must still be given training and hearing protection as required by this chapter.

**You must:**

- Make sure employees aren't exposed to workplace noise at least 14 hours before testing to establish a baseline audiogram.
  - Hearing protectors may be used to accomplish this.
- Notify employees of the need to avoid high levels of nonoccupational noise exposure (such as loud music, headphones, guns, power tools, motorcycles, etc.) during the 14-hour period immediately preceding the baseline audiometric examination.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-40010, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-40015 Conduct annual audiograms.****You must:**

- Conduct annual audiograms for employees as long as they continue to be exposed to noise that equals or exceeds 85 dBA TWA<sub>8</sub>.

*Note:* Annual audiometric testing may be conducted at any time during the work shift. By conducting the annual audiogram during the work shift with the employee exposed to typical noise for their job, the test may record a temporary threshold shift. This makes the test more sensitive to potential hearing loss and may help you improve employee protection before a permanent threshold shift occurs. A suspected temporary shift is one reason an employer may choose to retest employee hearing.

**You must:**

- Make sure each employee is informed of the results of his or her audiometric test.
  - Include whether or not there has been a hearing level decrease or improvement since their previous test.
- Make sure each employee's annual audiogram is compared to his or her baseline audiogram by an audiologist, otolaryngologist, another qualified physician, or the technician conducting the test to determine if a standard threshold shift has occurred.
  - If the annual audiogram indicates that an employee has suffered a standard threshold shift, you may obtain a retest within 30 days and consider the results of the retest as the annual audiogram.
- Make sure that an audiologist, otolaryngologist, or other qualified physician sees any annual audiogram that indicates a standard threshold shift.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-40015, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-40020 Review audiograms that indicate a standard threshold shift.****You must:**

- Make sure the health care professional supervising audiograms has:
  - A copy of this chapter
  - The baseline audiogram and most recent audiogram of the employee to be evaluated
  - Background noise level records for the testing room
  - Calibration records for the audiometer.
- Obtain an opinion from the health care professional supervising audiograms as to whether the audiograms indicate possible occupational hearing loss and any recommendations for changes in hearing protection
- Pay for any clinical audiological evaluation or otological examination required by the reviewer, if:
  - Additional review is necessary to evaluate the cause of hearing loss
  - OR**
  - If there is indication of a medical condition of the ear caused or aggravated by the wearing of hearing protectors.

- Inform the employee in writing of the existence of a standard threshold shift within 21 calendar days of the determination.
- Make arrangements for the reviewer to communicate to the employee any suspected medical conditions that are found unrelated to your workplace. This information is confidential and must be handled appropriately.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-40020, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-40025 Keep the baseline audiogram without revision, unless annual audiograms indicate a persistent threshold shift or a significant improvement in hearing.**

**You must:**

- Keep the baseline audiogram without revision, unless a qualified reviewer determines:
  - The standard threshold shift revealed by the audiogram is persistent
  - OR**
  - The hearing threshold shown in the annual audiogram indicates significant improvement over the baseline audiogram.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-40025, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-40030 Make sure a record is kept of audiometric tests.**

**You must:**

- Retain a legible copy of all employee audiograms conducted under this chapter.
  - Make sure the record includes:
    - Name and job classification of the employee
    - Date of the audiogram
    - The examiner's name
    - Date of the last acoustic or exhaustive calibration of the audiometer
    - Employee's most recent noise exposure assessment
    - The background sound pressure levels in audiometric test rooms.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-40030, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-40035 Make sure audiometric testing equipment meets these requirements.**

**You must:**

- Use 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 must be taken separately for each ear
  - Supra-aural headphones must be used.
- Conduct audiometric tests with audiometers (including microprocessor audiometers) that meet the specifications of, and are maintained and used according to, American National Standard Specification for Audiometers, S3.6-1996
- Check the functional operation of the audiometer each day before use by doing all of the following:
  - Make sure the audiometer's output is free from distorted or unwanted sound
  - Test either a person with known, stable hearing thresholds or a bio-acoustic simulator
  - Perform acoustic calibration for deviations of 10 dB or greater.
- Audiometer calibration must be checked acoustically at least annually to verify continued conformance with ANSI S3.6-1996. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this check
- An exhaustive calibration must be performed at least every 2 years according to the American National Standard Specification for Audiometers, S3.6-1996. Test frequencies below 500 Hz and above 6000 Hz may be omitted from the calibration.

- Provide audiometric test rooms that meet the requirements of ANSI S3.1-1999 American National Standard Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms using the following table of maximum ambient sound pressure levels:

Frequency (Hz)	500	1000	2000	4000	8000
Sound Pressure Level (dB)	40	40	47	57	62

*Note:* The American Industrial Hygiene Association and National Hearing Conservation Association recommend conducting audiograms using the requirements of ANSI S3.1-1999 American National Standard Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms with adjustments at only 500 Hz and below.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-40035, filed 05/19/03, effective 08/01/03.]

## OPTIONS TO AUDIOMETRIC TESTING

### WAC 296-817-500 Summary.

#### Your responsibility:

This section provides options to baseline audiometric testing for employees assigned to duties with noise exposures for **less than one year**. These program options may also be used to provide added assessment of longer-term employees in addition to audiometric testing.

The requirements of this section apply only if you decide to use auditing or a third-party hearing loss prevention program and do not conduct baseline audiometric testing for those employees.

#### Hearing Protection Audits

##### You must:

Conduct hearing protection audits at least quarterly

*WAC 296-817-50005*

Make sure staff conducting audits are properly trained

*WAC 296-817-50010*

Assess the hearing protection used by each employee during audits

*WAC 296-817-50015*

Document your hearing protection audits

*WAC 296-817-50020*

#### Third-Party Audiometric Testing

##### You must:

Make sure third-party hearing loss prevention programs meet the following requirements

*WAC 296-817-505*

##### Important:

**Hearing protection audits** are a tool for use in evaluating your hearing loss prevention program in cases where audiometric testing doesn't provide a useful measure. For example, if most of your employees are hired on a temporary basis for a few months at a time, audiometric testing may not identify the small changes in hearing acuity that could occur. Auditing provides an alternative to audiometric testing in these cases.

Auditing isn't required unless you use it in place of baseline audiometric testing for employees hired for a period of

**less than one year** and is permitted as a substitute for audiometric testing only for these employees.

**Third-party hearing loss prevention programs** are full hearing loss prevention programs and are distinct from audiometric testing provided by third parties as part of your own hearing loss prevention program. These programs may be organized by labor groups, trade associations, labor-management cooperatives, or other organizations to:

- Cover a specific group of employees
- OR**
- Combine efforts for several employers with common employees.

Although you remain responsible for the program, third-party programs can have at least 2 benefits over running your own program:

- The audiometric testing is portable between the participating employers so new testing won't be needed when an employee changes employers
- Employees who only work for short periods for any one employer can be monitored under the group program over a longer period of time increasing the effectiveness of the audiometric testing in preventing hearing loss for these employees.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-500, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-50005 Conduct hearing protection audits at least quarterly.**

**You must:**

- Conduct audits at least quarterly to provide a representative assessment of your workplace
  - The assessment is representative if it:
    - Covers all processes and work activities in your business at full production levels
    - AND**
    - Covers all employees present on the audit day.
  - If your business is mobile or involves variable processes, auditing may need to be repeated more often than quarterly
  - Auditing doesn't need to be repeated more than monthly as long as a reasonable effort is made to cover:
    - The activities with greatest exposure
    - AND**
    - As many employees as possible.
- Assess exposures and hearing protection for the full shift for each employee covered at the time of the audit.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-50005, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-50010 Make sure staff conducting audits are properly trained.**

**You must:**

- Make sure staff conducting hearing protection audits:
  - Can demonstrate competence in:
    - Evaluating hearing protection attenuation
    - Evaluating hearing protector choices
    - Assessing the correct use of hearing protectors.

- Are certified by the Council for Accreditation in Occupational Hearing Conservation (CAOHC) or have training in the following areas:
  - Noise and hearing loss prevention
  - Washington state noise regulations
  - Hearing protectors
  - Fitting of hearing protectors
  - Basic noise measurement
  - Hearing loss prevention recordkeeping.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-50010, filed 05/19/03, effective 08/01/03.]

#### **WAC 296-817-50015 Assess the hearing protection used by each employee during audits.**

##### **You must:**

- Confirm that:
  - Current site conditions during audits are consistent with conditions existing during noise monitoring
  - The hearing protection used by the employee is sufficient and appropriate for the conditions
  - The hearing protection is worn properly
  - The employees are satisfied with the performance and comfort of the hearing protection.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-50015, filed 05/19/03, effective 08/01/03.]

#### **WAC 296-817-50020 Document your hearing protection audits.**

##### **You must:**

- Keep a record of audit results for each employee assessed for the length of their employment and for the length of time you'll rely upon the audit results
- Include the following information in the record:
  - The make and model of the hearing protectors
  - The size of the protectors
  - Average noise exposure of the employee
  - Any problems found with use of the hearing protection
  - Any comments or complaints from the employee regarding the hearing protection.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-50020, filed 05/19/03, effective 08/01/03.]

### **THIRD-PARTY AUDIOMETRIC TESTS**

#### **WAC 296-817-50025 Make sure third-party hearing loss prevention programs meet the following requirements.**

##### **Important:**

Third-party hearing loss prevention programs are intended:

- For short-term employees hired or assigned to duties having noise exposures **for less than one year**  
**AND**
- **For seasonal employees.**

However, other employees may be included as long as you meet all requirements for hearing loss follow-ups and recordkeeping.

**You must:**

- Make sure that the third-party program is:
  - Equivalent to an employer program as required by this chapter
  - AND**
  - Uses audiometric testing to evaluate hearing loss.
- Make sure a licensed or certified audiologist, otolaryngologist, or other qualified physician administers the third-party program
- Make sure the third-party program has written procedures for:
  - Communicating with participating employers of program requirements
  - Follow-up procedures for detected hearing loss
  - Annual review of participating employer programs.
- Make sure the following program elements are corrected by you or the third-party program when deficiencies are found:
  - Noise exposures
  - Hearing protection
  - Employee training
  - Noise controls.
- Obtain a review of your hearing loss prevention program at least once per year, conducted by the third-party program administrator or their representative, in order to:
  - Identify any tasks needing a revised selection of hearing protection
  - AND**
  - Provide an overall assessment of the employers' hearing loss prevention activities.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-50025, filed 05/19/03, effective 08/01/03.]

**WAC 296-817-600 Noise definitions.**

**A-weighted** - An adjustment to sound level measurements that reflects the sensitivity of the human ear. Used for evaluating continuous or average noise levels.

**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 percent 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."

**Fast response** - A setting for a sound level meter that will allow the meter to respond to noise events of less than one second. Used for evaluating impulse and impact noise levels.

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**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 are measured using the fast response setting on a sound level meter.

**Noise dose** - The total noise exposure received by an employee during their shift. It can be expressed as a percentage indicating the ratio of exposure received to the noise exposure received in an 8-hour exposure to constant noise at 90 dBA. It may also be expressed as the sound level that would produce the equivalent exposure during an 8-hour period ( $TWA_8$ ).

**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.

**Permanent threshold shift** - A hearing level change that has become persistent and isn't expected to improve.

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

**Slow response** - A setting for sound level meters and dosimeters in which the meter doesn't register events of less than about one second. Used for evaluating continuous and average noise levels.

**Sound level** - The intensity of noise as indicated by a sound level meter.

**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.

**$TWA_8$  - Equivalent eight-hour time-weighted average sound level** - That sound level, which if constant over an 8-hour period, would result in the same noise dose measured in an environment where the noise level varies.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 03-11-060 (Order 02-16), § 296-817-500, filed 05/19/03, effective 08/01/03.]

**Helpful Tools**

Eliminating Noise.....R-2

Hearing Protection - Additional Information .....R-3

Noise Computation Examples .....R-4

## Eliminating Noise

How can noise be eliminated from the workplace?

When noise monitoring results indicate that workers are exposed to harmful noise levels, the best way to protect them is to eliminate the noise exposure versus using personal protective equipment. Using personal protective equipment can have many drawbacks and will not always be effective. Even small flaws in the fitting or use of hearing protection will significantly reduce its effectiveness. Sound can also be transmitted directly into the inner ear through the skull and have other effects on the body, so there are limits to the effectiveness of hearing protection. Small flaws in fitting or using an earplug or earmuff may not be apparent until a year or two after an employee starts using it, when follow-up testing is conducted. By that time irreparable hearing loss may have occurred.

### Eliminating Noise at the Source

Quieting the noise source directly will often be the most efficient way to reduce exposures. Most industrial noise is not part of the work, it is due to machinery operation or materials being worked on or handled. Often, small changes in equipment or processes can significantly reduce noise with little change in the efficiency or effectiveness of the work site. There are a variety of ways to reduce noises at the source:

- Install mufflers on engines.
- Use silencers wherever gases are being released, particularly on the exhausts from compressed air actuated equipment.
- Be sure equipment is in good operating condition—no squeaking parts, no rattling parts, etc.
- Be sure equipment is operating as designed—compressed air pressures are set at manufactures recommended levels, motion is within design limits and not hitting stops or other objects, impact pressure is set correctly.
- Use the correct equipment for the work—inefficient equipment may generate more noise and will usually generate noise for a longer time.
- Damp noise producing machine panels and materials. Some panels and materials will work like drums or bells to produce noise when they are shaken, vibrated or struck. Damping means to hold the materials tightly to prevent them from continuing to vibrate or adding materials that absorb the vibration energy.
- Move workstations further from noise sources.

In most cases, noise in the workplace is a sign of inefficiency—energy is being used to make noise rather than the products to be sold. The amount of energy necessary to create a harmful exposure is not great, but may be a sign of other inefficiencies in the system. Working to eliminate noise will often have benefits in improved efficiency and more effective production. A program to regularly monitor noise levels in the workplace will not only prevent over-exposure of employees, but may have added benefits such as identifying maintenance or adjustment problems with equipment and improving plant efficiency.

### Noise Enclosures and Barriers

Where noise cannot be eliminated at the source, the next form of noise control is to use engineering controls to intercept the sound as it travels from the noise source to the workers. The most effective way to do this is to create a closed box either around the equipment or the worker. Enclosing the sound source should also include adding acoustic insulation to absorb the sound being generated to make the enclosure as effective as possible. Special care must be taken to make sure materials can enter the enclosure and that cooling air and other equipment needs are accounted for without excessive openings into the enclosure. Using entry tunnels and baffles can allow full access to the machinery without compromising the effectiveness of the enclosure.

**Barriers**

Barriers may be simple walls or curtains of acoustic materials. Barriers have limited effectiveness unless they are very near either the noise source or the employee to be protected. Otherwise, the sound tends to simply travel around the barrier. Placing a barrier around a particularly noisy work area may limit the noise exposure of other workers, but will typically not reduce the exposure of workers performing the operation.

**Acoustical panels or baffles**

Acoustical panels or baffles are commonly installed near particularly noisy machinery, either on walls or ceilings. These can effectively cut down reflected noise, but do not address the direct noise exposure, which is usually much more significant. These panels and baffles are best suited as additions or treatments of enclosures or barriers.

**Buy Quiet Programs**

The engineering controls discussed above are often much more cost effective when they are planned and purchased with the equipment. Typically, the equipment will be fitted for the control system, or the controls will be installed during manufacture. This also eliminates the costs of studying and designing the noise controls. By considering noise during planning and purchasing of equipment, it is also possible to take advantage of plant layout and design to minimize noise problems. For example, if a particular machine will be the primary noise source in the plant, the production floor may be arranged to make it simpler to isolate that machine.

**Administrative Controls**

Another strategy to controlling noise exposures is to use administrative controls, in other words, to change work practices to minimize exposures. In some cases, simply scheduling work appropriately or moving workstations away from high noise areas can result in a significant reduction in noise exposure. Where specific tasks or machinery are the primary noise exposure for employees not working directly with those tasks, moving these employees to other locations may eliminate their noise exposure with little effect on the processes involved. Where employees must move from one location to another, paths should be provided allowing them to avoid high noise areas.

**Hearing Protection - Additional Information**

The most convenient method to use when evaluating the type of hearing protection needed 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. The NRR was developed for use in evaluating hearing protection from environmental sources measured with C-weighting.

The following methods must be used to calculate protected occupational exposure using A-weighted data as required under this rule:

- In general, it is best to fit hearing protection with a protected exposure sufficiently below the PEL to provide a safety factor. However, excessive protection, where the protected exposure is below about 70 dBA may interfere with communication and the employee's ability to hear activity or alarms around them.

**Examples:**

- Hearing protection example: 90 dBA exposure using earplugs with an NRR of 20 dB. The effective protection for the plugs is 13 dB and the protected exposure is 77 dBA, which is below the PEL.
- Dual hearing protection example: 105 dBA exposure using earplugs with an NRR of 33 dB and earmuff with a NRR of 29 dB. The effective protection is 31 dB and the protected exposure is 74 dB, which is below the PEL.

Instead of using the NRR, employers may evaluate the adequacy of hearing protector attenuation by using one of the three methods developed by the National Institute for Occupational Safety and Health (NIOSH), which are described in the List of Personal Hearing Protectors and Attenuation Data, HEW Publication No. 76-120, 1975, pages 21-37. These methods are known as NIOSH Methods No. 1, No. 2 and No. 3. The NRR described here 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, 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.

The employer must remember that calculated attenuation values reflect realistic values only to the extent that the protectors are properly fitted and worn.

More information on NRR:

- The 7 dB reduction is based on the typical difference between industrial noise as measured using A-weighting and the noise used in the laboratory to measure attenuation when the hearing protector is evaluated for determination of the NRR.
- If a value other than 7 dB would appear appropriate, the employer should use one of the alternate evaluation methods rather than using the NRR method.
- Similarly, the estimated NRR for dual hearing protection is based on typical results for such systems. Where a NRR specific to the dual protection system worn is available or other data allows use of the alternate evaluation methods, the employer may choose to do so.

### Noise Computation Examples

This helpful tool gives you examples of noise computations that should assist you

with your own computations. Also found in this helpful tool are examples of employer actions based on the specific noise computation results. You'll need to do your own noise computations and determine the specific actions needed based on the noise exposures in your workplace.

#### EXAMPLE 1

Assume an employee is exposed to 92 dBA for eight hours. Compute the employee's noise exposure, the time-weighted average and what action, if any, would be required of the employer.

**Exposure:**

$$D = 100 \times \left( \frac{C_1}{T_1} \right) = 100 \times \left( \frac{8}{6} \right) = 133\%$$

The exposure time is 8 hours. The reference duration for 92 dBA is 6 hours.

Time-weighted Average (TWA):

In Table HT-2, find the values for 130% and 135%. The difference in the time-weighted average values (92.2 - 91.6) equals 0.6. Since 133% is 3/5 of the way between 130 and 135, 133% equals 3/5 (0.6) + 91.6 = 92 dBA.

#### Employer Action

Since the employee's exposure is above the 90 dBA TWA, the employer would be required to institute a full hearing loss prevention program, including:

- Controlling noise as feasible,
- Providing hearing protection and training for employees,

**AND**

- Instituting an audiometric testing program.

**EXAMPLE 2**

Assume a continuous noise exposure for an employee of 90 dBA and a work shift of

8 a.m. to 4: 30 p.m. with a 15-minute morning and afternoon break and a 30-minute lunch. Both breaks and lunch are in an area with less than 70 dBA exposure. (Although this exposure could be integrated into the employee's total noise exposure, it is not significant and will not be considered in these calculations.) Calculate the worker's exposure, TWA, and the employer's responsibility.

**Exposure:**

Actual exposure (subtracting the lunch time and work breaks from the employee's work shift) indicates a 90 dBA exposure for 7-½ hours.  $D = 100 (C_1 / T_1) = 100 (7.5/8) = 94 (94\%)$

$$D = 100 \times \left( \frac{C_1}{T_1} \right) = 100 \times \left( \frac{7.5}{8} \right) = 94\%$$

Time-weighted Average (TWA):

From Table HT-2 a noise exposure of 94% converts to an equivalent 8-hour time-weighted average of 89.6 dBA.

**Employer Action:**

Since the employee's time-weighted average is between 85 and 90 dBA

TWA<sub>8</sub>, a hearing loss prevention program must be developed and maintained for the employee including hearing protection, training and audiometric testing. Engineering and/or administrative controls are not required, but may be beneficial, since the hearing loss prevention program would no longer be required if the employee's exposure were reduced below 85 dBA TWA<sub>8</sub>.

**EXAMPLE 3**

Assume a technician works in a noise enclosure booth with a noise exposure of less than 70 dBA. The technician makes rounds to read gauges and instruments that are located in an area with a noise level of 105 dBA. The technician makes four trips a day, and each trip lasts 30 minutes. Calculate the employee's noise exposure, TWA and employer's responsibility.

**Exposure:**

$$D = 100 \times \left( \frac{C_1}{T_1} \right) = 100 \times \left( \frac{2}{1} \right) = 200\%$$

With four trips a day and 30 minutes per trip, the employee is basically exposed to two hours of noise at 105 dBA with the remaining time spent inside the booth. From **Table HT-1** of the rule the reference duration for exposure at 105 dBA is 1 hour.

**Time-weighted Average:**

The employee's TWA from **Table HT- 2** is 95 dBA.

**Employer Action:**

Since the employee's exposure is above the 90 dBA TWA<sub>8</sub>, the employer would be required to institute a full hearing loss prevention program, including controlling noise as feasible, providing hearing protection and training for employees, and instituting an audiometric testing program.

**EXAMPLE 4**

Assume a timber trimmer operator with a background noise level inside the operator's booth of 85 Dba, cuts one timber every 10 seconds with a noise exposure during the cut of 105 Dba for three seconds. The employee works from 6 a.m. to 4:30 p.m. and has a 15-minute break in the morning and the afternoon and a 30-minute lunch break, all of which are below 70 Dba. Calculate the employee's noise exposure and TWA.

**Exposure:**First sound level - 105 dBA

The employee is exposed to this sound level for three seconds out of every ten or 30% of the time. Thus the time of exposure ( $C_1$ ) at this level is  $0.3 \times 9.5$  or 2.85 hours. From **Table HT-1**, the reference duration ( $T_1$ ) is one hour.

Second sound level - 85 dBA

The employee is exposed to this sound level for seven seconds out of every ten or 70% of the time. Thus the time of exposure ( $C_2$ ) at this level is  $0.7 \times 9.5$  or 6.65 hours. From **Table HT-1**, the reference duration ( $T_2$ ) is sixteen hours.

$$D = 100 \times \left( \frac{C_1}{T_1} + \frac{C_2}{T_2} \right) = 100 \times \left( \frac{2.85}{1} + \frac{6.65}{16} \right) = 327\%$$

**Time-weighted Average (TWA):**

From the conversion table we find a noise dose of 327% lies between 320 and 330 with values of 98.4 dBA and 98.6 dBA respectively.

$$320\% = 98.4 \text{ dBA}$$

$$330\% = 98.6 \text{ dBA}$$

$$327\% = (7/10) \times (0.2) + 98.4 = 98.5$$

**EXAMPLE 5**

Assume a security guard works an eight-hour shift and makes eight rounds a night. In making a round of the facility the guard will spend 20 minutes in Building A, 30 minutes in Building B and 10 minutes in the yard. In Building A the noise levels are less than 70 dBA. Noise level in the yard is 85 dBA. In Building B there is a cyclic machine operation where the noise levels are:

- 100 dBA for 3 seconds (30%)
- 95 dBA for 3 seconds (30%), and
- 90 dBA for 4 seconds (40%)

**Calculating the employee's noise exposure and time-weighted average (TWA):**

Since the employee's noise exposure in Building A is less than 70 dBA, this exposure is not significant and will not enter into the computation (the theoretical dose would be less than 2%). In Building B we find three noise exposures, 100, 95, and 90 dBA respectively. The yard also has an exposure (85 dBA), which will enter into the total computation.

Calculating the partial exposures at each noise level we find:

$$\text{At } 100 \text{ dBA} \\ 30\% \times \frac{30 \text{ minutes}}{\text{round}} \times \frac{8 \text{ rounds}}{\text{shift}} \times \frac{\text{hour}}{60 \text{ minutes}} = \frac{1.2 \text{ hours}}{\text{shift}}$$

$$\text{At } 95 \text{ dBA} \\ 30\% \times \frac{30 \text{ minutes}}{\text{round}} \times \frac{8 \text{ rounds}}{\text{shift}} \times \frac{\text{hour}}{60 \text{ minutes}} = \frac{1.2 \text{ hours}}{\text{shift}}$$

$$\text{At } 90 \text{ dBA} \\ 40\% \times \frac{30 \text{ minutes}}{\text{round}} \times \frac{8 \text{ rounds}}{\text{shift}} \times \frac{\text{hour}}{60 \text{ minutes}} = \frac{1.6 \text{ hours}}{\text{shift}}$$

$$\text{The yard at } 85 \text{ dBA} \\ \frac{10 \text{ minutes}}{\text{round}} \times \frac{8 \text{ rounds}}{\text{shift}} \times \frac{\text{hour}}{60 \text{ minutes}} = \frac{1.33 \text{ hours}}{\text{shift}}$$

The employee's total noise exposure can be calculated from the noise exposure formula using the following values.

Location	Sound Level	Time of Exposure	Reference Duration
Building B	100 dBA	$C_1 = 1.2 \text{ hours}$	$T_1 = 2 \text{ hours}$
Building B	95 dBA	$C_2 = 1.2 \text{ hours}$	$T_2 = 4 \text{ hours}$
Building B	90 dBA	$C_3 = 1.6 \text{ hours}$	$T_3 = 8 \text{ hours}$
Yard	85 dBA	$C_4 = 1.33 \text{ hours}$	$T_4 = 16 \text{ hours}$

The employee's total noise exposure (D) is computed as follows:

$$D = 100 \times \left( \frac{C_1}{T_1} + \frac{C_2}{T_2} + \dots + \frac{C_n}{T_n} \right) = 100 \times \left( \frac{1.2}{2} + \frac{1.2}{4} + \frac{1.6}{8} + \frac{1.33}{16} \right) = 118\%$$

**Table HT-1**  
**Reference Durations, in Hours, for given Noise Levels**

Noise Level, L	Reference Duration, T	Noise Level, L	Reference Duration, T
80	32.0	106	0.87
81	27.9	107	0.76
82	24.3	108	0.66
83	21.1	109	0.57
84	18.4	110	0.50
85	16.0	111	0.44
86	13.9	112	0.38
87	12.1	113	0.33
88	10.6	114	0.29
89	9.2	115	0.25
90	8.0	116	0.22
91	7.0	117	0.19
92	6.1	118	0.16
93	5.3	119	0.14
94	4.6	120	0.13
95	4.0	121	0.11
96	3.5	122	0.095
97	3.0	123	0.082
98	2.6	124	0.072
99	2.3	125	0.063
100	2.0	126	0.054
101	1.7	127	0.047
102	1.5	128	0.041
103	1.3	129	0.036
104	1.1	130	0.031
105	1.0	131	0.027

**Table HT-2**  
**Dose to Equivalent TWA<sub>8</sub> for Given Dose**

Dose	TWA <sub>8</sub>	Dose	TWA <sub>8</sub>	Dose	TWA <sub>8</sub>
10	<=70	350	99.0	670	103.7
20	78.4	360	99.2	680	103.8
30	81.3	370	99.4	690	103.9
40	83.4	380	99.6	700	104.0
50	85.0	390	99.8	710	104.1
60	86.3	400	100.0	720	104.2
70	87.4	410	100.2	730	104.3
80	88.4	420	100.4	740	104.4
90	89.2	430	100.5	750	104.5
100	90.0	440	100.7	760	104.6
110	90.7	450	100.8	770	104.7
120	91.3	460	101.0	780	104.8
130	91.9	470	101.2	790	104.9
140	92.4	480	101.3	800	105.0
150	92.9	490	101.5	810	105.1
160	93.4	500	101.6	820	105.2
170	93.8	510	101.8	830	105.3
180	94.2	520	101.9	840	105.4
190	94.6	530	102.0	850	105.4
200	95.0	540	102.2	860	105.5
210	95.4	550	102.3	870	105.6
220	95.7	560	102.4	880	105.7
230	96.0	570	102.6	890	105.8
240	96.3	580	102.7	900	105.8
250	96.6	590	102.8	910	105.9
260	96.9	600	102.9	920	106.0
270	97.2	610	103.0	930	106.1
280	97.4	620	103.2	940	106.2
290	97.7	630	103.3	950	106.2
300	97.9	640	103.4	960	106.3
310	98.2	650	103.5	970	106.4
320	98.4	660	103.6	980	106.5
330	98.6	670	103.7	990	106.5
340	98.8	680	103.8	1000	106.6

### SUMMARY

As you can see, the more variable the noise sources or exposure times, the more involved the computations become. Noise dosimeters overcome this problem by electronically accumulating and integrating the noise signals into the employee's noise dose. Having one person observe several noise dosimeters can save additional time. However, a simultaneous survey using a sound level meter must be conducted to support the dosimeter results

