160. OCCUPATIONAL NOISE EXPOSURE
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160. OCCUPATIONAL NOISE EXPOSURE. (7-1-97)

01. Scope: (7-1-97)

a. Occupational noise exposure shall conform to all other applicable requirements of this standard, as well as the following provisions. Nothing in this standard shall be construed to prohibit better or otherwise safer conditions than specified herein. (7-1-97)

02. Definitions: For definitions of other terms used in this section, see sub-section 010 of this standard. (7-1-97)

a. Action level is an eight (8) hour time weighted average of eighty-five (85) decibels measured on the A-scale, slow response; or equivalently, a noise dose of 50-percent. (7-1-97)

b. Audiogram is a chart, graph, or table resulting from an audiometric test showing an individual's hearing threshold levels as a function of frequency. (7-1-97)

c. Audiologist is a professional specializing in the study and rehabilitation of hearing, who is certified by the American Speech-Language-Hearing Association or licensed by a state board of examiners. (7-1-97)

d. Baseline Audiogram is the audiogram against which future audiograms are compared. (7-1-97)
e. Criterion Sound Level is a sound level of ninety (90) decibels. (7-1-97)

f. Decibel is a unit of measurement of sound level. (7-1-97)

g. Hertz (Hz) is a unit of measurement of frequency, numerically equal to cycles per second. (7-1-97)

h. Medical Pathology is a disorder or disease. For purposes of this section, a condition or disease affecting the ear, which would be treated by a physician specialist. (7-1-97)

i. Noise Dose is a percentage of the maximum allowable daily noise dose. For example, an eight (8) hour TWA exposure of ninety (90) dB = one-hundred (100) percent noise dose. (7-1-97)

j. Noise Dosimeter is 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. (7-1-97)

k. Otolaryngologist is a physician specializing in the diagnosis and treatment of disorders of the ear, nose, and throat. (7-1-97)

l. Representative Exposure are measurements of an employee's noise dose or eight (8) hour time weighted average sound level that employers deem to be representative of the exposures of other employees in the workplace. (7-1-97)

m. Sound Level Pressure (dB) = ten (10) 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 twenty (20) micropascals (ten (10) log (P1/Pref) two (2)). (7-1-97)

n. Sound Level Meter is an instrument for the measurement of sound level. (7-1-97)

o. Time Weighted Average Sound Level is that sound level, which if constant over an eight (8) hour exposure, would result in the same noise dose as is measured. (7-1-97)

03. General Requirements: (7-1-97)

a. Protection against the effect of noise exposure shall be provided when the sound levels exceed those shown in Table 160.03-A, when measured on the A scale of a standard sound level meter at slow response. (7-1-97)

<table>
<thead>
<tr>
<th>TABLE 160.03-A</th>
</tr>
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<tbody>
<tr>
<td>PERMISSIBLE NOISE EXPOSURES¹</td>
</tr>
<tr>
<td>Duration Per Day, Hour</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>

1. Values are based on a 8 hour time weighted average.
When the daily noise exposure is composed of two or more periods of noise exposure of difference levels, their combined effect should be considered, rather than the individual effect of each. When employees are exposed to different sound levels during the day, the mixed exposure must be calculated by using the following formula: \( \frac{C_1}{T_1} + \frac{C_2}{T_2} + \frac{C_3}{T_3} + \ldots \frac{C_n}{T_n} = D \) where each "C" is the total exposure time at a given noise level and each "T" is the total exposure time permitted at that level. If the sum of the fractions equals or exceeds 1, then the mixed exposure is considered to exceed the limit value. For example, an employee is exposed to the following noise levels during his work day: 85 dBA - 3.75 hours; 90 dBA - 2 hours; 95 dBA - 2 hours; 110 dBA - .25 hours. Thus, the sum of the fractions is as follows: \( \frac{3.75}{\text{no limit, (or 0)}} + \frac{2}{8} + \frac{2}{4} + \frac{0.25}{0.5} = 1.25 \). The mixed exposure exceeds the limit value. If the sum of the following fractions: \( \frac{C_1}{T_1} + \frac{C_2}{T_2} + \frac{C_n}{T_n} \) exceeds unity, then the mixed exposure should be considered to exceed the limit value. \( C_n \) indicates the total time of exposure at a specified noise level, and \( T_n \) indicates the total time of exposure permitted at that level.

(7-1-97)

**04. Equivalent Sound Level Contours:** (7-1-97)

a. When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined by using the graph in figure 160.04-A. (7-1-97)

**FIGURE 160.04-A BAND CENTER FREQUENCY IN CYCLES PER SECOND**
b. Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on the graph in Figure 160.04-A and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table 160.03-A. (7-1-97)

05. Engineering Controls: (7-1-97)

a. When employees are subjected to sound exceeding those listed in Table 160.03-A, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of Table 160.03-A, proper protective equipment shall be provided and used to reduce sound levels within the levels of the Table. (7-1-97)

06. Variations in Level: (7-1-97)

a. If the variations in noise level involve maxima at intervals of one (1) second or less, it is to be considered continuous. (7-1-97)

07. Hearing Conservation Program: (7-1-97)

a. In all cases where the sound levels equal or exceed an eight (8) hour time weighted average sound level (TWA) of eighty-five (85) decibels measured on the A scale (slow response) or, equivalently, a dose of fifty (50) percent, a continuing effective hearing conservation program shall be administered. (7-1-97)

b. For the purposes of the hearing conservation program, employee noise exposures shall be computed in accordance with sub-section 160.12 and table 160.12-A, and without regard to any attenuation provided by the use of personal protective equipment. (7-1-97)
c. For the purposes of this section, an eight (8) hour time weighted average of eighty-five (85) decibels or a dose of fifty (50) percent shall also be referred to as the action level. (7-1-97)

d. When information indicates that any employee's exposure may equal or exceed an eight (8) hour time weighted average of eighty-five (85) decibels, the employer shall develop and implement a monitoring program. The sampling strategy shall be designed to identify employees for inclusion in the hearing conservation program and to enable proper selection of hearing protectors. Where circumstances such as high mobility, significant variations in sound level, or a significant component of impulse noise make area monitoring generally inappropriate, the employer shall use representative personal sampling to comply with the monitoring requirements of this sub-section unless the employer can show that area sampling produces equivalent results. All continuous, intermittent, and impulsive sound levels from eighty (80) decibels to one-hundred-thirty (130) decibels shall be integrated into the noise measurements. Monitoring shall be repeated whenever a change in production, process, equipment, or controls increase noise exposures to the extent that: additional employees may be exposed at or above the action level; or the attenuation provided by hearing protectors being used by employees may be rendered inadequate to meet the requirements of sub-section 160.10.g of this section. (7-1-97)

e. The employer shall notify each employee exposed at or above an eight (8) hour time weighted average of eighty-five (85) decibels of the result of the monitoring. (7-1-97)

f. The employer shall provide affected employees or their representatives with an opportunity to observe any noise measurements conducted pursuant to this section. (7-1-97)

g. Exposure to impulsive or impact noise shall not exceed one-hundred-forty (140) db peak sound pressure level. (7-1-97)

08. Audiometric Testing Program: (7-1-97)

a. The employer shall establish and maintain an audiometric testing program as provided in this paragraph by making audiometric testing available to all employees whose exposure equal or exceed an eight (8) hour time weighted average of eighty-five (85) decibels. (7-1-97)

b. The program shall be provided at no cost to employees. (7-1-97)

c. Audiometric tests shall be performed by a licensed or certified audiologist, otolaryngologist, or physician. (7-1-97)

d. All audiograms obtained pursuant to this section shall meet the requirements of sub-section 160.09 of this section. (7-1-97)

e. Within six (6) months of an employee's first exposure at or above the action level, the employer shall establish a valid baseline audiogram against which subsequent audiograms can be compared. Where mobile test vans are used to meet the audiometric testing obligation, the employer shall obtain a valid baseline audiogram within one (1) year of an employee's first exposure at or above the action level. Where baseline audiograms are obtained more than six (6)
months after the employee's first exposure at or above the action level, employees shall wear
hearing protectors for any period exceeding six (6) months after the first exposure until the
baseline audiogram is obtained. (7-1-97)

f. Testing to establish a baseline audiogram shall be preceded by at least fourteen (14) hours
without exposure to workplace noise. Hearing protectors may be used as a substitute for the
requirement that baseline audiograms be preceded by fourteen (14) hours without exposure to
workplace noise. The employer shall notify employees of the need to avoid high levels of non-
occupational noise exposure during the fourteen (14) hour period immediately preceding the
audiometric examination. (7-1-97)

g. At least annually after obtaining the baseline audiogram, the employer shall obtain a new
audiogram for each employee exposed at or above an eight (8) hour time weighted average of
eighty (85) decibels. (7-1-97)

h. Each employee's annual audiogram shall be compared to that employee's baseline audiogram
to determine if the audiogram is valid and if a standard threshold shift has occurred. This
comparison may be done by a trained technician. If the annual audiogram shows that an
employee has suffered a standard threshold shift, the employer may obtain a retest within thirty
(30) days and consider the results of the retest as the annual audiogram. The audiologist,
otolaryngologist, or physician shall review problem audiograms and shall determine whether there
is a need for further evaluation. The employer shall provide to the person performing this
evaluation the following information: (7-1-97)

i. A copy of the requirements for hearing conservation as set forth in this section; (7-1-97)

ii. The baseline audiogram of the employee to be evaluated; (7-1-97)

iii. Measurements of background sound pressure levels in the audiometric test room as required
by this section for audiometric test rooms; (7-1-97)

iv. And records of audiometer calibrations as required by this section. (7-1-97)

i. If a comparison of the annual audiogram to the baseline audiogram indicated a standard
threshold shift as defined herein has occurred, the employee shall be informed of this fact in
writing, within twenty-one (21) days of the determination. Unless a physician determines that the
standard threshold shift is not work related or aggravated by occupational noise exposure, the
employer shall ensure that the following steps are taken when a standard threshold shift occurs:
employees not using hearing protectors shall be fitted with hearing protectors, trained in their use
and care, and required to use them; employees already using hearing protectors shall be refitted
and retrained in the use of hearing protectors and provided with hearing protectors offering
greater attenuation if necessary; and the employee shall be informed of the need for an otological
examination if a medical pathology of the ear that is unrelated to the use of hearing protectors is
suspected. (7-1-97)
j. If subsequent audiometric testing of an employee whose exposure to noise is less than an eight (8) hour time weighted average of ninety (90) decibels indicates that a standard threshold shift is not present, the employer shall inform the employee of the new audiometric interpretation; and may discontinue the required use of hearing protectors for that employee. (7-1-97)

k. An annual audiogram may be substituted for the baseline audiogram when, in the judgement of the audiologist, otolaryngologist, or physician who is evaluating the audiogram: the standard threshold shift revealed by the audiogram is persistent; the hearing threshold shown in the annual audiogram indicates significant improvement over the baseline audiogram. (7-1-97)

l. As used in this section, a standard threshold shift is a change in the hearing threshold relative to the baseline audiogram of an average of ten (10) dB or more at two-thousand (2000), three-thousand (3000), and four-thousand (4000) Hz in either ear. (7-1-97)

m. 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. (7-1-97)

**09. Audiometric Test Requirements** (7-1-97)

- **a.** Audiometric tests shall be pure tone, air conduction, hearing threshold examinations, with test frequencies including as a minimum five-hundred (500), one-thousand (1000), two-thousand (2000), three-thousand (3000), four-thousand (4000), and six-thousand (6000) Hz. Tests at each frequency shall be taken separately for each year. (7-1-97)

- **b.** Audiometric tests shall be conducted with audiometers (including microprocessor audiometers) that meet the specifications of, and are maintained in accordance with, the American National Standard Specification for Audiometers, S3.9. (7-1-97)

- **c.** Pulsed tone and self recording audiometers, if used, shall meet the requirements of sub-section 160.13 of this section. (7-1-97)

- **d.** Audiometric examinations shall be administered in a room meeting the following requirements: Rooms used for audiometric testing shall not have background sound pressure levels exceeding those in table 160.09-A when measured with equipment conforming to at least to the Type-two (2) requirements of American National Standard Specification for Sound Level Meters, S1.4 and to Class II requirements of American National Standard Specification for Octave, Half-Octave, and Third-octave Band Filter Sets, S1.11. (7-1-97)

<table>
<thead>
<tr>
<th>TABLE 160.09-A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAXIMUM ALLOWABLE OCTAVE-BAND SOUND PRESSURE LEVELS FOR AUDIOMATRIC TEST ROOMS</strong></td>
</tr>
<tr>
<td><strong>Octave-band center</strong></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>frequency (Hz)</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
<th>8000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound pressure level (dB)</td>
<td>40</td>
<td>40</td>
<td>47</td>
<td>57</td>
<td>62</td>
</tr>
</tbody>
</table>

## 10. Hearing Protectors: (7-1-97)

a. Employers shall make hearing protectors available to all employees exposed to an eight (8) hour time weighted average of eighty-five (85) decibels or greater at no cost to the employees. Hearing protectors shall be replaced as necessary. (7-1-97)

b. Employers shall ensure that hearing protectors are worn by an employee who is exposed to an eight (8) hour time weighted average of eighty-five (85) decibels or greater, has not yet had a baseline audiogram established pursuant to sub-section 160.08 of this section, or has experienced a standard threshold shift. (7-1-97)

c. Employees shall be given the opportunity to select their hearing protectors from a variety of suitable hearing protectors provided by the employer. (7-1-97)

d. The employer shall provide training in the use and care of all hearing protectors provided to employees. (7-1-97)

e. The employer shall ensure proper fitting and supervise the correct use of all hearing protectors. (7-1-97)

f. The employer shall evaluate hearing protector attenuation for the specific noise environments in which the protector will be used. The employer shall use one of the following methods for evaluating hearing protectors: the Noise Reduction Rating (NRR) developed by the Environmental Protection Agency (EPA); or the methods developed by the National Institute for Occupational Safety and Health (NIOSH). (7-1-97)

g. Hearing protectors must attenuate employee exposure at least to an eight (8) hour time weighted average of ninety (90) decibels. (7-1-97)

h. For employees who have experienced a standard threshold shift, hearing protectors must attenuate exposure to an eight (8) hour time weighted average of eighty-five (85) decibels or below. (7-1-97)

i. The adequacy of hearing protector attenuation shall be re-evaluated whenever employee noise exposures increase to the extent that the hearing protectors may no longer provide adequate attenuation. The employer shall provide more effective hearing protectors where necessary. (7-1-97)

## 11. Training: (7-1-97)
a. The employer shall institute a training program for all employees who are exposed to noise at or above an eight (8) hour time weighted average of eighty-five (85) decibels, and shall ensure employee participation in such program. (7-1-97)

b. The training program shall be repeated annually for each employee included in the hearing conservation program. Information provided in the training program shall be updated consistent with changes in protective equipment and work processes. (7-1-97)

c. The employer shall ensure that each employee is informed of the following: the effects of noise on hearing; the purpose of hearing protectors, disadvantages, and attenuating of various types, and instructions on selecting, fitting, use, and care; and the purpose of audiometric testing, and an explanation of the test procedures. (7-1-97)

d. The employer shall make available to affected employees or their representatives copies of this section and shall also have a copy available in the workplace. (7-1-97)

e. The employer shall provide to affected employees any informational materials pertaining to occupational noise exposure that are supplied by the Department. (7-1-97)

f. The employer shall provide, upon request, all materials related to the employer's training and education program pertaining to occupational noise exposure to the Director or his representative. (7-1-97)

12. Noise Exposure Computation: (7-1-97)

a. Noise dose is computed using table 160.12-A as follows: When the sound level, "L", is constant over the entire shift, the noise dose, "D", in percent, is given by; D=100C/T where "C" is the total length of the work day, in hours, and "T" is the reference duration corresponding to the measured sound level, "L", as given in table 160.12-A or by the formula shown at the end of the table. (7-1-97)

<table>
<thead>
<tr>
<th>L(DECIBEL)</th>
<th>T(HOUR)</th>
<th>L(DECIBEL)</th>
<th>T(HOUR)</th>
<th>L(DECIBEL)</th>
<th>T(HOUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>32</td>
<td>96</td>
<td>3.5</td>
<td>114</td>
<td>0.29</td>
</tr>
<tr>
<td>81</td>
<td>27.9</td>
<td>97</td>
<td>3.0</td>
<td>115</td>
<td>0.25</td>
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<tr>
<td>82</td>
<td>24.3</td>
<td>98</td>
<td>2.6</td>
<td>116</td>
<td>0.22</td>
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<tr>
<td>83</td>
<td>21.1</td>
<td>99</td>
<td>2.3</td>
<td>117</td>
<td>0.19</td>
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<td>18.4</td>
<td>100</td>
<td>2</td>
<td>118</td>
<td>0.16</td>
</tr>
</tbody>
</table>
In the above table the reference duration, T, is computed by

\[
T = \frac{8}{2((L-90)/5)}
\]

where L is the measured A-weighted sound level.

(7-1-97)

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

\[
D = 100 \left( \frac{C(1)}{T(1)} + \frac{C(2)}{T(2)} + ... + \frac{C(n)}{T(n)} \right)
\]

where C(n) indicates the total time of exposure at a specific noise level, and T(n) indicates the reference duration for that level as given by table 160.12-A. (7-1-97)

c. The eight (8) hour time weighted average sound level (TWA), in decibels, may be computed from the dose, in percent, by means of the formula:

\[
TWA = 16.61 \log(10) \left( \frac{D}{100} \right) + 90
\]

For an eight (8) hour work-shift with the noise level constant over the entire shift, the TWA is equal to the measured sound level. (7-1-97)
d. Compliance with section 160 of this standard is determined by the amount of exposure to noise in the workplace. The amount of such noise exposure is usually measured with an audiometer which gives a readout in terms of "dose". In order to convert the reading of a dosimeter into TWA, see table 160.12-B. This table applies to dosimeters that are set by the manufacturer to calculate dose or percent of exposure according to relationships in table 160.12-A. (7-1-97)

<table>
<thead>
<tr>
<th>Dose or percent noise exposure</th>
<th>TWA</th>
<th>TWA</th>
<th>TWA</th>
<th>TWA</th>
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<tr>
<td>10</td>
<td>73.4</td>
<td>104</td>
<td>90.3</td>
<td>260</td>
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<td>45</td>
<td>84.2</td>
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<td>88.7</td>
<td>130</td>
<td>91.9</td>
<td>440</td>
<td>100.7</td>
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</tbody>
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a. The functional operation of the audiometer shall be checked before each day's use by testing a person with known, stable hearing thresholds, and by listening to the audiometer's output to make sure that the output is free from distorted or unwanted sounds. Deviations of ten (10) decibels or greater require an acoustic calibration. (7-1-97)

b. Audiometer calibration shall be checked acoustically in accordance with the American National Standard Specification for Audimeters utilizing a sound level meter, octave-band filter set, and a National Bureau of standards nine (9) A coupler. Test frequencies below five (500) Hz and above six-thousand (6000) Hz may be omitted from this check. Deviations of fifteen (15) decibels or greater require an exhaustive calibration. (7-1-97)
c. An exhaustive calibration shall be performed at least every two (2) 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. Test frequencies below five-hundred (500) Hz and above six-thousand (6000) Hz may be omitted from this calibration. (7-1-97)

161. -- 169. (RESERVED)