For further information
Ph: 517-284-7740
www.michigan.gov/mioshastandards

DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS

DIRECTOR'S OFFICE

OCCUPATIONAL HEALTH STANDARDS

Filed with the Secretary of State on June 16, 1993 **(as amended November 16, 2016)**

These rules take effect immediately upon filing with the Secretary of State unless adopted under section 33, 44, or 45a(6) of 1969 PA 306.

Rules adopted under these sections become effective 7 days after filing with the Secretary of State.

(By authority conferred on the director of the department of licensing and regulatory affairs by sections 14 and 24 of 1974 PA 154, MCL 408.1014 and MCL 408.1024, and Executive Reorganization Order Nos. 1996-2, 2003-1, 2008-4, and 2011-4, MCL 445.2001, 445.2011, 445.2025, and 445.2030)

R 325.60102, R 325.60103, R 325.60104, R 325.60105, R 325.60107, R 325.60108, R 325.60109, R 325.60110, R 325.60111, R 325.60112, R 325.60115, R 325.60117, R 325.60118, R 325.60119, R 325.60120, R 325.60122, R 325.60123, R 325.60124, R 325.60125, and R 325.60126 of the Michigan Administrative Code are amended, R 325.60101a and R 325.60122a are added, and R 325.60127 and R 325.60128 are rescinded, as follows:

PART 380. OCCUPATIONAL NOISE EXPOSURE IN GENERAL INDUSTRY

Table of Contents:

R 325.60101 Applicability.

Rule 1. (1) These rules do not apply to the following types of employment:

(a) Domestic.
(b) Mining.
(c) Agriculture.
(d) Construction.

(2) R 325.60107 to R 325.60128 do not apply to employment in oil and gas well drilling and servicing operations.

R 325.60101a Adopted and referenced standards.

Rule 1a. (1) The following standards are adoption by reference in these rules and are available from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, telephone number 1-800-854-7179, website: www.global.ihs.com, at a cost as of the time of adoption of these rules, as stated in this subrule:

(a) American National Standard Institute ANSI S1.4 "American National Standard Electroacoustics - Sound Level Meters," 1983 edition. Cost: $120.00.

(b) ANSI S1.11 "American National Standard Specification For Octave-Band And Factional-Octave-Band Analog And Digital Filters," 1986 edition. Cost: $ 120.00.

(c) ANSI S3.6 "American National Standard Specification For Audiometers," 1969 edition. Cost: $ 25.00.

(d) ANSI S3.6 "American National Standard Specification For Audiometers," 1989 edition. Cost: $ 120.00.

(2) The National Institute for Occupational Safety and Health standard NIOSH 76-120 "List of Personal Hearing Protectors and Attenuation Data" NTIS Accession number: PB-267461, is adoption by reference in these rules and is available from the National Technical Information Service, 5301 Shawnee Road, Alexandria, Virginia 22312, telephone number: 1-800-553-6847, website: orders@ntis.gov, at a cost as of the time of adoption of this rule of $33.00.

(3) The standards adopted in these rules are available for inspection at the Department of Licensing and Regulatory Affairs, MIOSHA Regulatory Services Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909-8143.

(4) The standards adopted in these rules may be obtained from the publisher or may be obtained from the Department of Licensing and Regulatory Affairs, MIOSHA Regulatory Services Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909-8143, plus $20.00 for shipping and handling.

(5) This Michigan occupational safety and health (MIOSHA) standard is referenced in these rules, Occupational Health Standard Part 470 "Employee Medical Records and Trade Secrets," R 325.3451 to R 325.3476. Up to 5 copies of this standard may be obtained at no charge from the Department of Licensing and Regulatory Affairs, MIOSHA Regulatory Services Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909-8143 or via the internet at website: www.michigan.gov/mioshastandards. For quantities greater than 5, the cost, as of the time of adoption of these rules, is 4 cents per page.

(6) The appendices are informational only and are not intended to create any additional obligations or requirements not otherwise imposed or to detract from any established obligations or requirements.

R 325.60102 Definitions.

Rule 2. (1) "Action level" means an 8-hour, time-weighted average noise exposure of 85 decibels measured on the A-scale, slow response, or equivalently, a dose of 50%.

(2) "Audiogram" means a chart, graph, or table resulting from an audiometric test showing an individual's hearing threshold levels as a function of frequency.

(3) "Audiologist" means a professional who specializes in the study and rehabilitation of hearing and who is certified by the American Speech-Language-Hearing Association or licensed by a state board of examiners.

(4) "Baseline audiogram" means the audiogram against which future audiograms are compared.

(5) "Criterion sound level" means a sound level of 90 decibels.

(6) "Decibel" or "dB" means a unit of measurement of sound pressure level.

(7) "Hertz" or "Hz" means a unit of measurement of frequency and is numerically equal to cycles per second.

(8) "Medical pathology" means a condition or disease affecting the ear which should be treated by a physician specialist.

(9) "Noise dose" means the ratio, expressed as a percentage, of 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 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).

(10) "Noise dosimeter" means 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.

(11) "Otolaryngologist" means a licensed physician specializing in the diagnosis and treatment of disorders of the ear, nose, and throat.

(12) "Representative exposure" means the measurement of an employee's noise dose or 8-hour, time-weighted average noise exposure that the employer deems to be typically equivalent of the exposures of other employees in the workplace.

(13) "Sound level" means 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 20 micropascals and is expressed in units of dBA.

(14) "Sound level meter" means an instrument for the measurement of sound level.

(15) "Standard threshold shift" means a change in the hearing threshold relative to the baseline audiogram of an average of 10 dB or more at 2000, 3000, and 4000 Hz in either ear.

(16) "Time-weighted average sound level" means that sound level which, if constant over an 8-hour exposure, would result in the same noise dose as is measured.

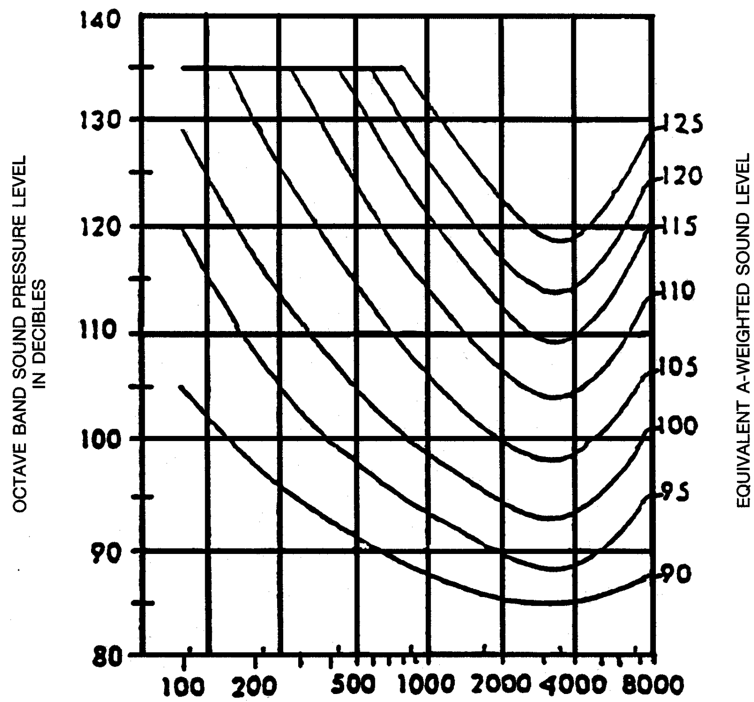
(17) "TWA" means time-weighted average.

R 325.60103 Protection from noise exposure.

Rule 3. (1) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table 1 of R 325.60104 when measured on the A scale of a standard sound level meter at slow response. If noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined as shown in Figure A.

(2) Figure A reads as follows:

FIGURE A



Equivalent sound level contours. Octave band sound pressure levels may be converted to the equivalent A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table 1 of R 325.60104.

R 325.60104 Permissible noise exposure; noise controls.

Rule 4. (1) If employees are subjected to sound exceeding the levels listed in Table 1, feasible administrative or engineering controls shall be utilized. If the controls fail to reduce sound levels within the levels listed in Table 1, personal protective equipment shall be provided and used to reduce employee noise exposure within those levels listed in Table 1.

(2) Table 1 reads as follows:

TABLE 1
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

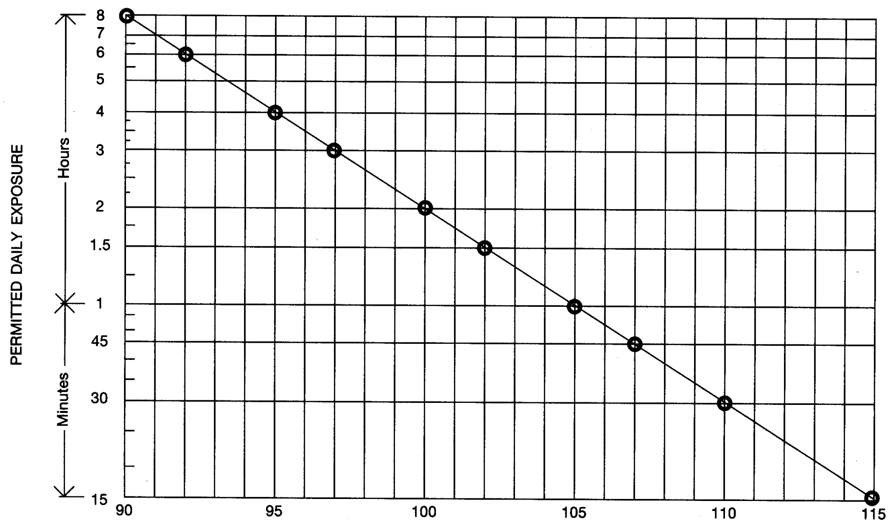
[1] When the daily noise exposure is composed of 2 or more periods of noise exposure of different levels, their combined effect shall be considered, rather than the individual effect of each. If the sum of C(1)/T(1) + C(2)/T(2) +…+ C(n)/T(n) exceeds unity, then the mixed exposure shall be considered to exceed the limit value. C(n) indicates the total time of exposure at a specified noise level, and T(n) indicates the total time of exposure permitted at that level. Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

R 325.60105 Determination of permitted daily exposure time.

Rule 5. (1) If a noise level is between 2 listed permissible noise levels prescribed by Table 1 of R 325.60104(2), Chart A shall be used to determine the permitted daily exposure time. In applying Chart A, measured noise levels shall be taken to the nearest whole number.

(2) Chart A reads as follows:

CHART A
NOISE EXPOSURE CHART



Measured Noise Level, dBA, Slow Response

R 325.60106 Impact or impulse noise.

Rule 6. (1) The maximum permissible level for impact or impulse noise shall be 140 dB as measured with a sound level meter capable of indicating an instantaneous peak noise level.

(2) Impact and impulse noise are those peaks or maxima of sound level, above the continuous background level, which have separation intervals greater than 1 second. If peaks are 1 second or less apart, the noise shall be considered to be continuous.

R 325.60107 Hearing conservation program.

Rule 7. (1) The employer shall administer a continuing, effective hearing conservation program, as described in R 325.60108 to R 325.60127, when employee noise exposures equal or exceed the action level.

(2) For purposes of the hearing conservation program, employee noise exposures shall be computed in accordance with the provisions of R 325.60110 and Table 2 and without regard to any attenuation provided by the use of personal protective equipment.

R 325.60108 Noise monitoring program.

Rule 8. (1) When information indicates that any employee's exposure may equal or exceed the action level, the employer shall develop and implement a noise-monitoring program with all of the following characteristics:

(a) The noise monitoring strategy shall be designed to identify employees for inclusion in the hearing conservation program and to enable the proper selection of hearing protectors, if required.

(b) Where circumstances such as high worker mobility, significant variations in sound level, or a significant component of impulse or impact noise make area monitoring generally inappropriate, the employer shall use representative personal monitoring to comply with the monitoring requirements of this rule, unless the employer can show that area monitoring produces equivalent results.

(c) All continuous, intermittent, and impulse or impact sound levels from 80 dBA to 130 dBA shall be integrated into the noise measurements.

(d) Instruments used to measure employee noise exposure shall be calibrated to ensure measurement accuracy.

(2) Noise monitoring shall be repeated when a change in production, process, equipment, or controls increases noise exposure to the extent that either of the follow apply:

(a) Additional employees may be exposed at or above the action level.

(b) The attenuation provided by hearing protectors being used by employees may be rendered inadequate to meet the requirements of R 325.60122.

R 325.60109 Employee observation and notification.

Rule 9. (1) The employer shall provide affected employees or their representatives an opportunity to observe any noise measurements conducted pursuant to the provisions of R 325.60108.

(2) The employer shall notify each employee exposed at or above the action level of the results of the monitoring pertaining to that employee.

R 325.60110 Noise exposure determination.

Rule 10. (1) Exposure measurements shall accurately reflect employee exposure.

(2) All continuous, intermittent, and impulsive sound levels from 80 dBA to 130 dBA shall be integrated into the computation.

(3) An employee's noise dose shall be computed using Table 2 as follows:

(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 work period in hours, and T is the reference duration corresponding to the measured sound level, L, as given in Table 2, 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 for the workday is given by:

$D = 100(C(1)/T(1) + C(2)/T(2) + . . . + C(n)/T(n))$
where C(n) indicates the total time of exposure at a specific noise level, and T(n) indicates the reference duration for that level as given by Table 2.

(4) Table 2 reads as follows:

TABLE 2			
A–weighted sound level, L (decibel)	**Reference duration, T (hour)**	**A-weighted sound level, L (decibel)**	**Reference duration, T (hour)**
80	32	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	0.5
85	16	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	116	0.22
91	7	117	0.19
92	6.1	118	0.16

TABLE 2			
A–weighted sound level, L (decibel)	**Reference duration, T (hour)**	**A-weighted sound level, L (decibel)**	**Reference duration, T (hour)**
93	5.3	119	0.14
94	4.6	120	0.125
95	4	121	0.11
96	3.5	122	0.095
97	3	123	0.082
98	2.6	124	0.072
99	2.3	125	0.063
100	2	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		

In the above Table, the reference duration, T, is computed by:

$$T = \frac{8}{2^{\left(\frac{L-90}{5}\right)}}$$

where L is the measured A-weighted sound level.

R 325.60111 Determining TWA sound levels.

Rule 11. (1) Time-weighted average (TWA) sound levels may be computed from the measured or calculated dose by means of the formula:

$$TWA = 16.61 \log_{10} \frac{D}{12.5T} + 90$$

where D is the dose in percentage,
and T is the time in hours over which the dose was determined.

(2) An 8-hour TWA sound level can be calculated from the formula in subrule (1) of this rule by letting T equal 8. Thus,

$$TWA = 16.61 \log_{10} \frac{D}{100} + 90$$

Table 3 gives the 8-hour, TWA sound level values for a wide range of dose values.

(3) Table 3 reads as follows:

TABLE 3
EIGHT-HOUR TWA SOUND LEVELS

Dose (in percent)	TWA Sound Level (in dBA)	Dose (in percent)	TWA Sound Level (in dBA)	Dose (in percent)	TWA Sound Level (in dBA)	Dose (in percent)	TWA Sound Level (in dBA)
10	73.4	104	90.3	260	96.9	640	103.4
15	76.3	105	90.4	270	97.2	650	103.5
20	78.4	106	90.4	280	97.4	660	103.6
25	80.0	107	90.5	290	97.7	670	103.7
30	81.3	108	90.6	300	97.9	680	103.8
35	82.4	109	90.6	310	98.2	690	103.9
40	83.4	110	90.7	320	98.4	700	104.0
45	84.2	111	90.8	330	98.6	710	104.1
50	85.0	112	90.8	340	98.8	720	104.2
55	85.7	113	90.9	350	99.0	730	104.3
60	86.3	114	90.9	360	99.2	740	104.4

TABLE 3 EIGHT-HOUR TWA SOUND LEVELS							
Dose (in percent)	**TWA Sound Level (in dBA)**	**Dose (in percent)**	**TWA Sound Level (in dBA)**	**Dose (in percent)**	**TWA Sound Level (in dBA)**	**Dose (in percent)**	**TWA Sound Level (in dBA)**
65	86.9	115	91.1	370	99.4	750	104.5
70	87.4	116	91.1	380	99.6	760	104.6
75	87.9	117	91.1	390	99.8	770	104.7
80	88.4	118	91.2	400	100.0	780	104.8
81	88.4	119	91.3	410	100.2	790	104.9
82	88.6	120	91.3	420	100.4	800	105.0
83	88.7	125	91.6	430	100.5	810	105.1
84	88.7	130	91.9	440	100.7	820	105.2
85	88.8	135	92.4	450	100.8	830	105.3
86	88.9	140	92.7	460	101.0	840	105.4
87	89.0	145	92.9	470	101.2	850	105.4
88	89.1	150	93.2	480	101.3	860	105.5
89	89.2	155	93.4	490	101.5	870	105.6
90	89.2	160	93.6	500	101.6	880	105.7
91	89.3	165	93.6	510	101.8	890	105.8
92	89.4	170	93.8	520	101.9	900	105.8
93	89.5	175	94.0	530	102.0	910	105.9
94	89.6	180	94.2	540	102.2	920	106.0
95	89.6	185	94.4	550	102.3	930	106.1
96	89.7	190	94.6	560	102.4	940	106.2
97	89.8	195	94.8	570	102.6	950	106.2
98	89.9	200	95.0	580	102.7	960	106.3
99	89.9	210	95.4	590	102.8	970	106.4
100	90.0	220	95.7	600	102.9	980	106.5
101	90.1	230	96.0	610	103.0	990	106.5
102	90.1	240	96.3	620	103.2	999	106.6
103	90.2	250	96.6	630	103.3	1000	106.6

R 325.60112 Audiometric testing program.

Rule 12. (1) The employer shall establish and maintain an audiometric testing program as provided in this rule by making audiometric testing available to all employees whose exposures equal or exceed the action level.

(2) The program shall be provided at no cost to employees.

(3) Audiometric tests shall be performed by a licensed or certified audiologist, otolaryngologist, or other physician, or by a technician who is certified by the council of accreditation in occupational hearing conservation or who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and properly using, maintaining, and checking calibration and proper functioning of the audiometers being used. A technician who operates microprocessor audiometers does not need to be certified. A technician who performs audiometric tests shall be responsible to an audiologist, otolaryngologist, or physician.

(4) All audiograms obtained pursuant to the provisions of R 325.60113 and R 325.60114 shall meet the applicable requirements of R 325.60119.

R 325.60113 Baseline audiogram.

Rule 13. (1) Within 6 months of an employee’s first exposure at or above the action level, the employer shall establish a valid baseline audiogram against which subsequent audiograms can be compared.

(2) Where mobile test vans are used to meet the audiometric testing requirement, the employer shall obtain a valid baseline audiogram within 1 year of an employee’s first exposure at or above the action level. Where baseline audiograms are obtained more than 6 months after the employee’s first exposure at or above the action level, employees shall wear hearing protectors for any period exceeding 6 months after first exposure until the baseline audiogram is obtained.

(3) Testing to establish a baseline audiogram shall be preceded by a period of not less than 14 hours without exposure to workplace noise. Hearing protectors may be used as a substitute for the requirement of 14 hours without exposure to workplace noise.

(4) The employer shall notify employees of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination.

R 325.60114 Annual audiogram.

Rule 14. At least annually after obtaining the baseline audiogram, the employer shall obtain a new audiogram for each employee exposed at or above the action level.

R 325.60115 Evaluation of audiogram.

Rule 15. (1) Each employee's annual audiogram shall be compared to that employee's baseline audiogram to determine if the audiogram is valid and if a standard threshold shift, as defined by R 325.60102(15), has occurred. This comparison may be done by a technician.

(2) If the annual audiogram shows that the employee has suffered a standard threshold shift, the employer may obtain a retest within 30 days and consider the results of the retest as the annual audiogram.

(3) An audiologist, otolaryngologist, or physician shall review problem audiograms and shall determine whether there is a need for further evaluation. The employer shall provide to the person performing this evaluation the following information:

(a) A copy of the requirements for hearing conservation as set forth in this rule, R 325.60107 to R 325.60114, and R 325.60116 to R 325.60127.

(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 pursuant to the provisions of R 325.60119(5).

(d) Records of audiometer calibrations required pursuant to the provisions of R 325.60120.

R 325.60116 Follow-up procedures.

Rule 16. (1) If a comparison of the annual audiogram to the baseline audiogram indicates a standard threshold shift has occurred, the employee shall be informed of this fact, in writing, within 21 days of the determination.

(2) Unless a physician determines that the standard threshold shift is not work-related or aggravated by occupational noise exposure, the employer shall ensure that all of the following steps are taken when a standard threshold shift occurs:

(a) Employees not using hearing protectors shall be fitted with hearing protectors meeting the attenuation standards as outlined in R 325.60122, trained in their use and care, and required to use them.

(b) Employees already using hearing protectors shall be refitted and retrained in the use of hearing protectors and provided with hearing protectors offering greater attenuation if necessary.

(c) The employee shall be referred for a clinical audiological evaluation or an otological examination, as appropriate, if additional testing is necessary or if the employer suspects that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors.

(d) The employee is informed of the need for an otological examination if the medical pathology of the ear that is unrelated to the use of hearing protectors is suspected.

(3) If subsequent audiometric testing of an employee whose noise exposure is less than the permissible 8-hour, TWA of 90 dB indicates that a standard threshold shift is not persistent, the employer shall inform the employee of the new audiometric interpretations and may discontinue the required use of hearing protectors for that employee.

R 325.60117 Revised baseline audiograms.

Rule 17. 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, either of the following apply:

(a) The standard threshold shift revealed by the audiogram is persistent.

(b) The hearing threshold shown in the annual audiogram indicates significant improvement over the baseline audiogram.

R 325.60118 Standard threshold shift determination.

Rule 18. (1) 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 adjusting the most recent audiogram. If the adjustment is made, the employer shall, for each audiometric test frequency, do both of the following:

(a) Determine from Table 4 the age correction values for the employee as follows:

(i) Find the age at which the most recent audiogram was taken and record the corresponding values of age corrections at 1000 Hz to 6000 Hz.

(ii) Find the age at which the baseline audiogram was taken and record the corresponding values of age corrections at 1000 Hz to 6000 Hz.

(b) Subtract the values found in subdivision (a)(ii) from the values found in subdivision (a)(i). The differences represent that portion of the change in hearing that may be due to aging.

EXAMPLE: Employee is a 32-year-old male. The audiometric history for the employee’s right ear is shown in decibels below.

Employee's age	**Audiometric test frequency (Hz)**				
	1000	**2000**	**3000**	**4000**	**6000**
26	10	5	5	10	5
*27	0	0	0	5	5
28	0	0	0	10	5
29	5	0	5	15	5
30	0	5	10	20	10
31	5	10	20	15	15
*32	5	10	10	25	20

The audiogram at age 27 is considered the baseline since it shows the best hearing threshold levels. Asterisks have been used to identify the baseline and most recent audiogram. A threshold shift of 20 dB exists at 4000 Hz between the audiograms taken at ages 27 and 32.

The threshold shift is computed by subtracting the hearing threshold at age 27, which was 5, from the hearing threshold at age 32, which is 25.

A retest audiogram has confirmed this shift. The contribution of aging to this change in hearing may be estimated in the following manner:

Go to Table 4 and find the age correction values (in dB) for 4000 Hz at age 27 and age 32.

	Frequency (Hz)				
	1000	**2000**	**3000**	**4000**	**6000**
Age 32	6	5	7	10	14
Age 27	5	4	6	7	11
Difference	1	1	1	3	3

The difference represents the amount of hearing loss that may be attributed to aging in the time period between the baseline audiogram and the most recent audiogram. In this example, the difference at 4000 Hz is 3 dB. This value is subtracted from the hearing level at 4000 Hz, which in the most recent audiogram is 25, yielding 22 after adjustment. Then the hearing threshold in the baseline audiogram at 4000 Hz (5) is subtracted from the adjusted annual audiogram-hearing threshold at 4000 Hz (22). Thus the age corrected threshold shift would be 17 dB (as opposed to a threshold shift of 20 dB without age correction).

(2) Table 4 reads as follows:

TABLE 4												
AGE CORRECTION VALUES IN DECIBELS												
MALES							**FEMALES**					
Age	**1000 Hz**	**2000 Hz**	**3000 Hz**	**4000 Hz**	**6000 Hz**		**1000 Hz**	**2000 Hz**	**3000 Hz**	**4000 Hz**	**6000 Hz**	**Age**
20 or less	5	3	4	5	8		7	4	3	3	6	20 or less
21	5	3	4	5	8		7	4	4	3	6	21
22	5	3	4	5	8		7	4	4	4	6	22
23	5	3	3	6	9		7	5	4	4	7	23
24	5	3	5	6	9		7	5	4	4	7	24
25	5	3	5	7	10		8	5	4	4	7	25
26	5	4	5	7	10		8	5	5	4	8	26
27	5	4	6	7	11		8	5	5	5	8	27
28	6	4	6	8	11		8	5	5	5	8	28
29	6	4	6	8	12		8	5	5	5	9	29
30	6	4	6	9	12		8	6	5	5	9	30
31	6	4	7	9	13		8	6	6	5	9	31
32	6	5	7	10	14		9	6	6	6	10	32
33	6	5	7	10	14		9	6	6	6	10	33
34	6	5	8	11	15		9	6	6	6	10	34

TABLE 4												
AGE CORRECTION VALUES IN DECIBELS												
MALES							FEMALES					
Age	1000 Hz	2000 Hz	3000 Hz	4000 Hz	6000 Hz		1000 Hz	2000 Hz	3000 Hz	4000 Hz	6000 Hz	Age
35	7	5	8	11	15		9	6	7	7	11	35
36	7	5	9	12	16		9	7	7	7	11	36
37	7	6	9	12	17		9	7	7	7	12	37
38	7	6	9	13	17		10	7	7	7	12	38
39	7	6	10	14	18		10	7	8	8	12	39
40	7	6	10	14	19		10	7	8	8	13	40
41	7	6	10	14	20		10	8	8	8	13	41
42	8	7	11	16	20		10	8	9	9	13	42
43	8	7	12	16	21		11	8	9	9	14	43
44	8	7	12	17	22		11	8	9	9	14	44
45	8	7	13	18	23		11	8	10	10	15	45
46	8	8	13	19	24		11	9	10	10	15	46
47	8	8	14	19	24		11	9	10	11	16	47
48	9	8	14	20	25		12	9	11	11	16	48
49	9	9	15	21	26		12	9	11	11	16	49
50	9	9	16	22	27		12	10	11	12	17	50
51	9	9	16	23	28		12	10	12	12	17	51
52	9	10	17	24	29		12	10	12	13	18	52
53	9	10	18	25	30		13	10	13	13	18	53
54	10	10	18	26	31		13	11	13	14	19	54
55	10	11	19	27	32		13	11	14	14	19	55
56	10	11	20	28	34		13	11	14	15	20	56
57	10	11	21	29	35		13	11	15	15	20	57
58	10	12	22	31	36		14	12	15	16	21	58
59	11	12	22	32	37		14	12	16	16	21	59
60 or older	11	13	23	33	38		14	12	16	17	22	60 or older

R 325.60119 Audiometric test requirements.

Rule 19. (1) Audiometric tests shall be pure tone, air conduction, hearing threshold examinations, with test frequencies that include, at a minimum, 500, 1000, 2000, 3000, 4000, and 6000 Hz. Tests at each frequency shall be taken separately for each ear.

(2) Audiometric tests shall be conducted with audiometers, including microprocessor audiometers, that meet the specifications of, and are maintained and used in accordance with ANSI S3.6 "American National Standard Specification For Audiometers," 1989 edition, as adopted in R 325.60101a.

(3) Pulsed-tone audiometers, if used, shall have a tone on-time of not less than 200 milliseconds.

(4) Self-recording audiometers, if used, shall be in compliance with all of the following requirements:

(a) The chart upon which the audiogram is traced shall have lines at positions that correspond to all multiples of 10 dB hearing level within the intensity range spanned by the audiometer. The lines shall be equally spaced and shall be separated by not less than 1/4 of an inch. Additional increments are optional. The audiogram pen tracings shall not be more than 2 dB in width.

(b) It shall be possible to set the stylus manually at the 10 dB increment lines for calibration purposes.

(c) The slewing rate for the audiometer attenuator shall not be more than 6 dB/second, except that an initial slewing rate of more than 6 dB/second is permitted at the beginning of each new test frequency, but only until the second subject response.

(d) The audiometer shall remain at each required test frequency for 30 seconds plus or minus 3 seconds. The audiogram shall be clearly marked at each change of frequency, and the actual frequency change of the audiometer shall not deviate from the frequency boundaries marked on the audiogram by more than plus or minus 3 seconds.

(e) It shall be possible at each test frequency to place a horizontal line segment parallel to the time axis on the audiogram so that the audiometric tracing crosses the line segment not less than 6 times at that test frequency. At each test frequency, the threshold shall be the average of the midpoints of the tracing excursions.

(5) Audiometric examinations shall be administered in a room or booth that has sound pressure levels that do not exceed any of the following:

(a) 40 dB at 500 Hz center frequency.
(b) 40 dB at 1000 Hz center frequency.
(c) 47 dB at 2000 Hz center frequency.
(d) 57 dB at 4000 Hz center frequency.
(e) 62 dB at 8000 Hz center frequency.

Sound levels will be determined by a type 1 or type 2 sound level meter and octave-band filter as specified by the requirements of ANSI S1.4 "American National Standard Electroacoustics - Sound Level Meters," 1983 edition, and ANSI S1.11 "American National Standard Specification For Octave-Band And Factional-Octave-Band Analog And Digital Filters," 1986 edition, as adopted in R 325.60101a.

R 325.60120 Audiometer calibration.

Rule 20. (1) 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 more than 10 dB shall require an acoustic calibration.

(2) Audiometer calibration shall be checked acoustically at least annually in accordance with all of the following procedures and instructions. 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.

(a) The equipment that is necessary to perform these measurements is a sound level meter, octave-band filter set, and a National Bureau of Standards 9A coupler. In making these measurements, the accuracy of the calibrating equipment shall be sufficient to determine that the audiometer is within the tolerances permitted by ANSI S3.6 "American National Standard Specification For Audiometers," 1989 edition, as adopted in R 325.60101a.

(b) Sound pressure output check procedures are as follows:

(i) Place the earphone coupler over the microphone of the sound level meter and place the earphone on the coupler.
(ii) Set the audiometer's hearing threshold level (HTL) dial to 70 dB.
(iii) Measure the sound pressure level of the tones at each test frequency from 500 Hz to 6000 Hz for each earphone.
(iv) At each frequency, the readout on the sound level meter shall correspond to the levels in Table 5 or Table 6, as appropriate for the type of earphone, in the column entitled "Sound level meter reading."

(c) Linearity check procedures are as follows:

(i) With the earphone in place, set the frequency to 1000 Hz and the HTL dial on the audiometer to 70 dB.
(ii) 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.
(iii) For each 10-dB decrement on the audiometer, the sound level meter shall indicate a corresponding 10-dB decrease.
(iv) This measurement may be made electrically with a voltmeter that is connected to the earphone terminals.

(d) If a measured sound level deviates from a level in Table 5 or Table 6 by plus or minus 3 dB at any test frequency between 500 and 3000 Hz, plus or minus 4 dB at 4000 Hz, or plus or minus 5 dB at 6000 Hz, an exhaustive calibration is advised. An exhaustive calibration is required if the deviation is 15 dB or more at any test frequency.

(e) Table 5 reads as follows:

TABLE 5		
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

(f) Table 6 reads as follows:

TABLE 6		
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. A deviation of 15 dB or more requires an exhaustive calibration.		

(3) An exhaustive calibration shall be performed at least once every 2 years in accordance with the provisions of Table 7. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this calibration.

TABLE 7
ANSI S3.6 "American National Standard Specification For Audiometers" 1969 edition, as adopted in R 325.60101a.
The Following Sections:
4.1.2
4.1.3
4.1.4.3
4.2
4.4.1
4.4.2
4.4.3
4.5

R 325.60121 Hearing protectors.
Rule 21. (1) Employers shall, at no cost to the employees, make hearing protectors available to all employees who are exposed to noise at or above the action level. Hearing protectors shall be replaced as necessary.

(2) Employers shall ensure that hearing protectors are worn by the following persons:

(a) Employees who are exposed above the permissible level and are required to be protected in accordance with the provisions of R 325.60103(1) and R 325.60104(1).

(b) Employees who are exposed above the action level, but less than the permissible level, and who have not yet had a baseline audiogram taken pursuant to the provisions of R 325.60113(2) or who have experienced a standard threshold shift.

(3) Employees shall be given the opportunity to select their hearing protectors from a variety of suitable hearing protectors that are provided by the employers.

(4) An employer shall provide training in the use and care of all hearing protectors that are provided to employees.

(5) An employer shall ensure proper initial fitting and supervise the correct use of all hearing protectors.

R 325.60122 Hearing protector attenuation.
Rule 22. (1) An employer shall evaluate hearing protector attenuation for the specific noise environments in which the protector will be used in accordance with the procedures specified in R 325.60122a.

(2) Hearing protectors shall attenuate employee exposure at least to an 8-hour time-weighted average of 90 decibels as required by the provisions of R 325.60103 and R 325.60104.

(3) For employees who have experienced a standard threshold shift, hearing protectors shall attenuate employee exposures at or below the action level.

(4) The adequacy of hearing protector attenuation shall be reevaluated where employee noise exposures increase to the extent that the hearing protectors provided might no longer provide adequate attenuation. The employer shall provide more effective hearing protectors where necessary.

R 325.60122a Methods for estimating the adequacy of hearing protector attenuation.

Rule 22a. (1) For an employee who has experienced a standard threshold shift, hearing protector attenuation must be sufficient to reduce employee exposure to a TWA of 85 dB. An employer shall select 1 of the following methods by which to estimate the adequacy of hearing protector attenuation:

(a) The most convenient method is the Noise Reduction Rating (NRR) developed by the Environmental Protection Agency (EPA). According to EPA regulation, the NRR must be shown on the hearing protector package. The NRR is then related to an individual worker's noise environment in order to assess the adequacy of the attenuation of a given hearing protector. This rule describes 4 methods of using the NRR to determine whether a particular hearing protector provides adequate protection within a given exposure environment. Selection among the 4 procedures is dependent upon the employer's noise measuring instruments.

(b) Instead of using the NRR, an employer may evaluate the adequacy of hearing protector attenuation by using 1 of the 3 methods developed by NIOSH 76-120 'List of Personal Hearing Protectors and Attenuation Data" NTIS Accession number: PB-267461, pages 21-37, as adopted in R 325.60101a. 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 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 in subrule (2) of this rule, if 1 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. An employer must take a sufficient number of measurements 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.

(2) When using the NRR to assess hearing protector adequacy, 1 of the following methods shall be used:

(a) When using a dosimeter that is capable of C-weighted measurements, both of the following apply:

(i) Obtain the employee's C-weighted dose for the entire workshift, and convert to TWA, see R 325.60111.

(ii) 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:

(i) Convert the A-weighted dose to TWA, see Table 3.

(ii) Subtract 7 dB from the NRR.

(iii) 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, both of the following apply:

(i) Obtain the employee's A-weighted TWA.

(ii) 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, both of the following apply:

(i) Obtain a representative sample of the C-weighted sound levels in the employee's environment.

(ii) 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-weighing network, both of the following apply:

(i) Obtain a representative sound level for the area in question.

(ii) 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, both of the following apply:

(i) Obtain a representative sound level for the area in question.

(ii) Subtract the NRR from the C-weighted sound level for that area.

R 325.60123 Employee training program.

Rule 23. (1) The employer shall train each employee who is exposed to noise at or above the action level in accordance with the requirements of these rules. The employer shall institute a training program and ensure employee participation in the program.

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

(3) The employer shall ensure that each employee is informed of all of the following:

(a) The effects of noise on hearing, see Appendix A.

(b) The purpose of hearing protectors; the advantages, disadvantages, and attenuation of various types of hearing protectors; and instructions on the selection, fitting, use, and care of hearing protectors.

(c) The purpose of audiometric testing, and an explanation of the test procedures.

R 325.60124 Access to information and training materials.

Rule 24. (1) The employer shall make copies of these rules available to affected employees or their representatives and shall also post a copy in the workplace.

(2) The employer shall provide to affected employees any informational materials pertaining to these rules that are supplied to the employer by the Michigan Occupational Safety and Health Administration (MIOSHA).

(3) The employer shall provide, upon request by a MIOSHA official, all materials related to the employer's training and education program pertaining to these rules.

R 325.60125 Recordkeeping.

Rule 25. (1) An employer shall maintain an accurate record of all employee exposure measurements required by the provisions of R 325.60108 to R 325.60111.

(2) An employer shall retain all employee audiometric test records that are obtained pursuant to the provisions of R 325.60112 to R 325.60114. These records shall include all of the following information:

(a) Name and job classification of the employee.

(b) Date of the audiogram.

(c) Examiner's name.

(d) Date of last acoustic or exhaustive calibration of the audiometer.

(e) Employee's most recent noise exposure assessment.

(3) An employer shall maintain accurate records of the measurements of the background sound pressure levels in audiometric test rooms required by the provisions of R 325.60119(5).

R 325.60126 Records; retention; provision; access; transfer.

Rule 26. (1) The employer shall retain records required in R 325.60125 for at least the following periods:

(a) Noise exposure measurement records shall be retained for 2 years.

(b) Audiometric test records shall be retained for the duration of the affected employee's employment.

(2) All records required by the provisions of R 325.60125 shall be provided, upon request, to employees, former employees, representatives designated by the individual employee, and MIOSHA officials. The provisions of Occupational Health Standard Part 470 “Employee Medical Records and Trade Secrets,” as referenced in R 325.60101a, shall apply to access to records under this rule.

(3) If the employer ceases to do business, the employer shall transfer to the successor employer all records required to be maintained by this rule, and the successor employer shall retain them for the remainder of the period or periods prescribed in subrule (1) of this rule.

R 325.60127 Rescinded.

R 325.60128 Rescinded.

APPENDIX A
METHODS FOR ESTIMATING THE ADEQUACY OF HEARING PROTECTOR ATTENUATION

Note: This Appendix A is a copy of Appendix B (entitled as above) to 29 C.F.R. §1910.95 'Occupational Noise Exposure.'

For employees who have experienced a standard threshold shift, hearing protector attenuation must be sufficient to reduce employee exposure to a TWA of 85 dB. Employers must select one of the following methods by which to estimate the adequacy of hearing protector attenuation.

The most convenient method is the Noise Reduction Rating (NRR) developed by the Environmental Protection Agency (EPA). According to EPA regulation, the NRR must be shown on the hearing protector package. The NRR is then related to an individual worker's noise environment 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 employer's noise measuring instruments.

Instead of using 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 #1, #2 and #3. The NRR described below is a simplification of NIOSH method #2. The most complex method is NIOSH method #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. Employers should be careful to take a sufficient number of measurements in order to achieve a representative sample for each time segment.

Note: The employer must remember that calculated attenuation values reflect realistic values only to the extent that the protectors are properly fitted and worn. When using the NRR to assess hearing protector adequacy, one of the following methods must be used:

(i) When using a dosimeter that is capable of C-weighted measurements:
- (a) Obtain the employee's C-weighted dose for the entire workshift, and convert to TWA (see Appendix A, II).
- (b) Subtract the NRR from the C-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(ii) When using a dosimeter that is not capable of C-weighted measurements, the following method may be used:
- (a) Convert the A-weighted dose to TWA (see Appendix A).
- (b) Subtract 7 dB from the NRR.
- (c) Subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(iii) When using a sound level meter set to the A-weighting network:
- (a) Obtain the employee's A-weighted TWA.
- (b) Subtract 7 dB from the NRR, and subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector.

(iv) When using a sound level meter set on the C-weighing network:
- (a) Obtain a representative sample of the C-weighted sound levels in the employee's environment.
- (b) Subtract the NRR from the C-weighted average sound level to obtain the estimated A-weighted TWA under the ear protector.

(v) When using area monitoring procedures and a sound level meter set to the A-weighing network.
- (a) Obtain a representative sound level for the area in question.
- (b) Subtract 7 dB from the NRR and subtract the remainder from the A-weighted sound level for that area.

(vi) When using area monitoring procedures and a sound level meter set to the C-weighing network:
- (a) Obtain a representative sound level for the area in question.
- (b) Subtract the NRR from the C-weighted sound level for that area.

APPENDIX B
SOUND, HEARING, AND THE CONSEQUENCES OF EXCESSIVE EXPOSURE TO NOISE

1. Sound.

Noise can be described as an undesirable airborne sound. Sound, in turn, is a pressure phenomenon. The human ear can hear, without damage, a sound pressure ten million times greater than the sound pressure of the softest sound it can sense. The apparent loudness that we attribute to a sound varies not only with the sound pressure, but also with the frequency, or a pitch, of the sound. The audible range of sound for the average human ear is from 20 Hertz (cycles per second, abbreviated “Hz”) to 16,000 Hz. In the measurement of sound the A-weighting network or scale of a standard sound level meter is used to evaluate its effect on people or rate the hazard of a certain noise.

Although to many laymen the decibel (abbreviated “dB”) is uniquely associated with noise measurements, it is a term borrowed from electrical communications engineering and it represents a relative quantity. When it is used to express noise level, a reference quantity is implied, generally a sound pressure of 20 micro-newtons per square meter (20 uN/m2). For purposes of hearing conservation, the reference level can be referred to as “zero decibels”--the starting point of the scale of noise level. This starting point is about the level of the weakest sound that can be heard by a person with very good hearing in an extremely quiet location. For example, the noise level of a soft whisper is around 30 dB; a private office, 50 dB; the average production plant office, 60-70 dB. Among the very loud sounds are those produced by nearby airplanes, railroad trains, riveting machines, etc., which are in the range near 100 dB. Keep in mind when relating noise measurements to hearing that our hearing mechanism does not measure sound pressure. What we hear is a function of loudness.

2. Hearing.

As sound waves are carried through the air and reach the outer ear, they are collected into the external ear canal and directed toward the eardrum. As the sound waves converge on the eardrum, they cause this sensitive membrane to vibrate and the setting up of these vibrations by the eardrums is the first step in the hearing process. As the eardrum vibrates, the vibrations are transmitted through the middle ear chiefly by means of a series of three small bones known as the ossicular chain. The smallest perceived by the malleus and transmitted along the chain. Next in order is the incus (anvil) and then the stapes (stirrup). Attached to the malleus and stapes bones are two small muscles which, by reflexly contracting, serve as protection against very loud sounds and thus prevent too forceful a movement of bones of the ossicular chain. While these muscles may provide some protection from continuous noise--especially at low frequencies--they have little protective effect in screening sudden noises because the reflex action of the muscles is not sufficiently rapid. The stapes has a small footplate that fits exactly into the oval window which marks the inner boundary of the middle ear. The stapes is attached to this oval window by a flexible or elastic membrane and as vibrations are received by the stapes along the chain from the eardrum the footplate moves in and out the oval window in a manner perhaps best described as similar to the motion used in tapping one’s foot.

The primary function of the middle ear is to conduct the sound waves to the fluid of the inner ear without significant loss. This it does essentially by matching the impedance of the sound waves in the air to that of the sound waves in the fluid. If, for any reason, the ossicular chain is removed from the middle ear, a loss of about 30 dB in hearing is experienced. It is the middle ear which helps us to hear very faint sound as the result magnifying the force of vibration on the order of twenty-five times the original force. The oval window into which the footplate of the stapes fits is an opening in the bony wall of the cochlea--the area we call the inner ear. The cochlea is a bony coil of about 2.5 turns filled with a clear fluid and somewhat resembles a snail shell. As the footplate of the stapes goes in and out of the opening--as a result of the vibrations from the eardrum--the fluid within the cochlea receives alternate positive and negative pressure at an extremely rapid rate. The bony chamber of the cochlea has only one other outlet (known as the round window), which is also closed by an elastic membrane, and the action of the stapedial footplate thus causes fluid waves to form the inner ear. The coil is divided into two compartments. The division is partially made by an incomplete bony shelf and a basilar membrane lies a tube-like structure known as the scala media which follows the turns of the cochlea. Inside the entire length of the scala media is a very sensitive mechanism of hearing called the organ of Corti containing between 20,000 and 30,000 minute sensory cells from which very fine hairs extend. On top of these hair cells is a fine gelatinous membrane known as the tectorial frequencies of the sound the ear is transmitting. Fluid waves produced by tones of high frequency stimulate the hair cells at the lower or basal end of the cochlea. Those produced by low frequencies chiefly stimulate hair cells toward the upper end.

As the fluid waves--put in motion by the stapedial footplate at the oval window of the cochlea--selectively stimulate the hair cells, the nerves at the base of the hair cells gather together the impulses thus generated into a sort of cable that carries them along the eighth nerve and into the various sections of the brain. When the impulses reach the cortex of the brain the sensation of hearing is experienced.

This is a brief and much simplified account of the hearing process which is, in fact, a most complex operation. Sounds such as speech, which are not pure tones, are taken into the ear, broken down into pure tones somewhere in the inner ear and nervous system, and conducted along the nerve cable as nerve impulses (not sound) until they reach the brain. Somewhere in the brain these nerve impulses, which are thought to consist of electrical and chemical phenomena, are integrated and interpreted as meaningful speech. This remarkable ability of the ear to analyze and break down speech sounds into their fundamental frequencies is still the wonder of investigators.

3. Consequences of Excessive Exposure.

Hearing loss resulting from exposure to loud noise is termed acoustic trauma and such loss may be either conductive or perceptive (nerve) in character. Occasionally it may even be a combination of both. Acoustic trauma of the conductive type (blast trauma) is usually the result of a loud explosion that ruptures the eardrum. The inner ear is infrequently damaged in such instances, but the ossicular chain of the middle ear can be completely dislodged. The perceptive type of acoustic trauma results from prolonged exposure to sudden sharp noises, such as gunfire. The eardrum is rarely affected; the damage occurs to the inner ear. Our chief concern is with the perceptive type of acoustic trauma, which is generally termed “occupational” or “industrial” deafness. This may also be subdivided into two types--temporary (auditory fatigue) and permanent deafness; but when the term occupational or industrial deafness is used, it refers in nearly all instances to the permanent type of perceptive hearing loss.

In the early stages of industrial deafness the first evidence of hearing loss is usually evident in the frequency region of 4000 to 6000 Hz. As the damaging noise continues and causes further hearing loss, the frequencies just above and below 4000 Hz begin to become involved. The damage can become so severe as to also involve the lower tones, even as low as 250 Hz and below. In all instances of this type of damage, the bone conduction is also markedly reduced, indicating that the damage occurs in the inner ear. In most instances when an employee showing some degree of industrial deafness is removed from the noisy environment, his hearing loss will not continue to progress. After a period away from the noise there may even be some improvement in hearing due to the reversal of any temporary fatigue that may be present, but the damage to the inner ear often shows itself in permanent deafness.

The effect of noise on an individual’s hearing is not the result of a single cause, but will depend on many factors: the susceptibility of the individual; the duration of exposure including the time patterns; the intensity of the noise; the spectrum of the noise; the type of noise--impact, random, or simple tone; and the nature of the ear protection used, if any.

Although research on the effects of noise is not complete, it appears that noise can cause quickened pulse rate, increased blood pressure and a constriction of blood vessels. Over a long period of time, these may place an added burden on the heart. Noise may also put stress on other parts of the body by causing the abnormal secretion of hormones and tensing of muscles. Workers exposed to noise sometimes complain of nervousness, sleepiness, and fatigue. Excessive noise exposure also can reduce job performance and may cause high rates of absenteeism.

APPENDIX C
CONTROL OF NOISE

1. General.

These rules on occupational noise require employers to protect employees from hazardous noise exposure and define four ways to provide this protection. Two of the four; engineering and work practice controls are directed at reducing the noise levels in the workplace and should be considered as the more desirable means of protection. Administrative controls and personal hearing protection do nothing to limit the noise levels, but can reduce employee exposure to an acceptable degree. The purpose of this Appendix is to briefly describe three noise control methods; engineering, work practice and administrative controls. The fourth, personal hearing protection, is covered in Appendix A.

2. Engineering Noise Control.

This is a complex, technical subject which deserves text book coverage rather than the very limited treatment which can be provided here. This material will attempt to classify and outline the many facets of engineering noise control to help employers select and apply effective control techniques.

Before one attempts to control noise it is important to determine the characteristics of the noise at its source. The technology of noise control is such that obtaining an octave band analysis is a significant first step to selecting and applying engineering controls. Octave band analysis cannot only help determine what techniques will be most effective, but in many cases will help pinpoint the specific noise source.

Noise is best controlled by not creating it in the first place. This means the first consideration should be in the design and fabrication of new plants, equipment, tooling, etc. Facilities and machinery can be designed, built and installed in a manner to minimize the generation and transmission of noise. Another way of curtailing the noise generated is to maintain equipment in an "as designed" condition. Paying close attention to plant equipment by regular and proper maintenance of such things as lubrication, bearings, seals, gears, power transmission, enclosures, etc., an often go a long way to minimize the generation of noise. One common source of hazardous and annoying noise in industry is the high frequency sound of high pressure air escaping from an air line, nozzle or other outlet. This source can usually be controlled by using a muffler at the point of discharge to reduce turbulence and velocity.

The next area for attention is substitution of equipment, processes, and materials. A larger fan running at a slower speed will be less noisy, and belt drives are generally quieter than direct drives. Welding will produce less noise (but more toxic air contaminants) than riveting. Materials used in production and equipment can make a significant difference in the noise generated. Most metals are "live," meaning they have little internal damping; but other materials like plastics, wood, lead, etc. are relatively "dead." Maximum use of materials with a high degree of internal damping can significantly reduce noise levels. When live materials must be used, deadening materials and techniques can be applied.

When the generation of noise is unavoidable, the best control approach is to modify the sound path to minimize the amount that reaches the ear. This can be done in a number of ways, no one way is the best answer to every situation. Often a noisy machine can be isolated with vibration dampers to prevent the sound from being transmitted by floors, walls, ceilings, etc. A rubber pad between typewriter and desk, or specifically designed vibration isolation springs under a large press are examples of this principle. Another means of modifying the sound path is to cover vibrating surfaces with resilient materials which attenuate transmitted sound. Often hazardous noise exposures are the result of sound being reflected from walls and ceilings. This can be helped by covering those surfaces with materials that absorb, rather than reflect, sound; although there are often less expensive ways of dealing with the problem. Often the best solution, where feasible, is to enclose the noise source--the noise is contained within a box or room with provisions established for material handling, ventilation, maintenance, etc. Such enclosures must be designed and built to high standards with proper materials if they are to be effective.

The converse of machine enclosures is to enclose the worker. Sound attenuating booths or rooms from which the workers can operate and monitor production by remote methods are practical where the noise sources are extensive and the work force is small. Partial enclosures and even simple shields or barriers between source and receiver can be effective to "shadow" the worker from medium and high frequency noise, but not low frequencies.

To summarize, it is best to avoid generating noise by careful attention to design and specification of facilities, then by maintaining them in an "as designed" condition. Next, seek to eliminate noise sources by retrofitting with mufflers, lower velocities of air and liquids, and substitution of noisy materials, components, processes, etc. Control of unavoidable noise sources may be affected by vibration isolation, damping of surfaces, reduction of speeds, room absorption, enclosures and barriers.

3. Work Practice Controls

These deal with how the work is done rather than with the physical facilities. For example, a metal part dropped two feet into a metal tray will generate more noise than if the same part is placed in the tray with a negligible impact. Unnecessary sounding of hi-low horns may add significantly to the workplace noise levels. Dull cutting tools should be replaced before they increase noise exposures. An important consideration with work practice controls is that they depend upon the worker for constant application. The employee must be trained how and why to do a task the quiet way and then generally needs to be supervised to maintain the desired control. Often the quiet way is not the easiest or fastest way to perform a task.

4. Administrative Controls.

These controls involve actions taken by management to reduce the exposure of employees to noise, not to reduce the noise levels. It means scheduling of work and employees to do that work so that no one, or a minimum number of workers, are exposed to excessive noise levels. To be effective, administrative controls must be carefully planned and faithfully executed. They are less desirable than engineering controls because they tend to expose more workers to noise levels that may be almost as hazardous as those that exceed permitted levels. More employees doing different jobs means more training and maybe less production with lower quality. Also, terms of labor contracts may make these controls difficult to implement.

APPENDIX D
MONITORING NOISE LEVELS

Note: This Appendix D is a copy of Appendix G (entitled as above) to 29 C.F.R. §1910.95 'Occupational Noise Exposure.'

This appendix provides information to help employers comply with the noise monitoring obligations that are part of the hearing conservation amendment.

1. What is the purpose of noise monitoring?

This revised amendment requires that employees be placed in a hearing conservation program if they are exposed to average noise levels of 85 dB or greater during an 8 hour workday. In order to determine if exposures are at or above this level, it may be necessary to measure or monitor the actual noise levels in the workplace and to estimate the noise exposure or "dose" received by employees during the workday.

2. When is it necessary to implement a noise monitoring program?

It is not necessary for every employer to measure workplace noise. Noise monitoring or measuring must be conducted only when exposures are at or above 85 dB. Factors which suggest that noise exposures in the workplace may be at this level include employee complaints about the loudness of noise, indications that employees are losing their hearing, or noisy conditions which make normal conversation difficult. The employer should also consider any information available regarding noise emitted from specific machines. In addition, actual workplace noise measurements can suggest whether or not a monitoring program should be initiated.

3. How is noise measured?

Basically, there are two different instruments to measure noise exposures: the sound level meter and the dosimeter. A sound level meter is a device that measures the intensity of sound at a given moment. Since sound level meters provide a measure of sound intensity at only one point in time, it is generally necessary to take a number of measurements at different times during the day to estimate noise exposure over a workday. If noise levels fluctuate, the amount of time noise remains at each of the various measured levels must be determined.

To estimate employee noise exposures with a sound level meter it is also generally necessary to take several measurements at different locations within the workplace. After appropriate sound level meter readings are obtained, people sometimes draw "maps" of the sound levels within different areas of the workplace. By using a sound level "map" and information on employee locations throughout the day, estimates of individual exposure levels can be developed. This measurement method is generally referred to as "area" noise monitoring.

A dosimeter is like a sound level meter except that it stores sound level measurements and integrates these measurements over time, providing an average noise exposure reading for a given period of time, such as an 8-hour workday. With a dosimeter, a microphone is attached to the employee's clothing and the exposure measurement is simply read at the end of the desired time period. A reader may be used to read-out the dosimeter's measurements. Since the dosimeter is worn by the employee, it measures noise levels in those locations in which the employee travels. A sound level meter can also be positioned within the immediate vicinity of the exposed worker to obtain an individual exposure estimate. Such procedures are generally referred to as "personal" noise monitoring.

Area monitoring can be used to estimate noise exposure when the noise levels are relatively constant and employees are not mobile. In workplaces where employees move about in different areas or where the noise intensity tends to fluctuate over time, noise exposure is generally more accurately estimated by the personal monitoring approach.

In situations where personal monitoring is appropriate, proper positioning of the microphone is necessary to obtain accurate measurements. With a dosimeter, the microphone is generally located on the shoulder and remains in that position for the entire workday. With a sound level meter, the microphone is stationed near the employee's head, and the instrument is usually held by an individual who follows the employee as he or she moves about.

Manufacturer's instructions, contained in dosimeter and sound level meter operating manuals, should be followed for calibration and maintenance. To ensure accurate results, it is considered good professional practice to calibrate instruments before and after each use.

4. How often is it necessary to monitor noise levels?

The amendment requires that when there are significant changes in machinery or production processes that may result in increased noise levels, re-monitoring must be conducted to determine whether additional employees need to be included in the hearing conservation program. Many companies choose to re-monitor periodically (once every year or two) to ensure that all exposed employees are included in their hearing conservation programs.

5. Where can equipment and technical advice be obtained?

Noise monitoring equipment may be either purchased or rented. Sound level meters cost about $500 to $1,000, while dosimeters range in price from about $750 to $1,500. Smaller companies may find it more economical to rent equipment rather than to purchase it. Names of equipment suppliers may be found in the telephone book (Yellow Pages) under headings such as: "Safety Equipment," "Industrial Hygiene," or "Engineers-Acoustical." In addition to providing information on obtaining noise monitoring equipment, many companies and individuals included under such listings can provide professional advice on how to conduct a valid noise monitoring program. Some audiological testing firms and industrial hygiene firms also provide noise monitoring services. Universities with audiology, industrial hygiene, or acoustical engineering departments may also provide information or may be able to help employers meet their obligations under this amendment.

[61 FR 9227, March 7, 1996]

MIOSHA CONSULTATION EDUCATION AND TRAINING DIVISION

To learn more about the free on-site services available from the MIOSHA Consultation Education and Training (CET) Division, or to request a visit:

- **Call the Lansing office at 517-284-7720 or 800-866-4674.**
- **Submit your request electronically at www.michigan.gov/cetrca.**
- **View our website at www.michigan.gov/miosha.**

LARA
LICENSING AND REGULATORY AFFAIRS
CUSTOMER DRIVEN. BUSINESS MINDED.

Michigan Occupational Safety and Health Administration
PO Box 30643
Lansing, Michigan 48909-8143
Ph: 517-284-7740