

مركز أبوظبي للصحة المهنية
ABU DHABI OCCUPATIONAL SAFETY AND HEALTH CENTER

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Abu Dhabi Occupational Safety and Health System Framework

(OSHAD-SF)

Code of Practice

CoP 3.0 – Occupational Noise

Version 3.1

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ABU DHABI PUBLIC
HEALTH CENTRE

مركز أبوظبي
للصحة العامة



Important Note:

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Table of Contents

1.	Introduction	3
2.	Training and Competency.....	4
3.	Requirements.....	5
3.1	Roles and Responsibilities	5
3.2	Noise Risk Assessment	6
3.3	Hearing Conservation Program.....	7
3.4	Noise Hazard Signage	11
3.5	Audiometric Measuring Instruments.....	11
3.6	Audiometric Test Rooms.....	12
3.7	Computation of Employee Noise Exposure	12
3.8	Computation of Hearing Protection Attenuation	13
4.	Record Keeping.....	14
5.	References.....	15
6.	Document Amendment Record	16
	APPENDIX 1: Allowable Duration of Exposure Based on Sound Level dB(A)	17
	APPENDIX 2: Calculating dB(A) Using Octave Band Analysis Data	18
	APPENDIX 3: Calculation of Allowable Noise:	20
	APPENDIX 4: Computation of Hearing Protection Attenuation.....	21

1. Introduction

- (a) This Code of Practice (CoP) applies to all employers within the Emirate of Abu Dhabi. This CoP is designed to incorporate requirements set by UAE and Abu Dhabi Regulatory Authorities. If requirements of this document conflict with requirements set by another regulatory authority, employers are required to follow the more stringent requirement.
- (b) This CoP establishes the requirements and standards so that the risks associated where employees, contractors or visitors could be exposed to noise levels at or in excess of 85 decibels (dB) as measured on an A-weighted scale at any time during a work shift are managed in an appropriate manner.

2. Training and Competency

- (a) Employers shall ensure that OSH training complies with the requirements of:
- (i) *OSHAD-SF – Element 5 – Training, Awareness and Competency;*
 - (ii) *OSHAD-SF – Mechanism 7.0 – OSH Professional Entity Registration; and*
 - (iii) *OSHAD-SF– Mechanism 8.0 – OSH Practitioner Registration.*
- (b) Employers shall provide training to all employees exposed to noise at or in excess of an 8-hr time weighted average of 85 dB(A). Training shall be conducted within 30 days of starting work and prior to working in a high noise area, and include:
- (i) requirements of this CoP;
 - (ii) health hazards associated with exposure to noise above 85 dB(A);
 - (iii) signs and symptoms of noise exposure and hearing loss;
 - (iv) types of hearing loss;
 - (v) information on the employer’s hearing conservation program;
 - (vi) the purpose of hearing protectors along with the advantages, disadvantages, and attenuation of various types of hearing protectors;
 - (vii) instructions on selection, fitting, use, and care of hearing protectors;
 - (viii) purpose of audiometric testing and explanation of the testing procedures; and
 - (ix) locations within the facility where noise hazards exists and hearing protection is required.
- (c) Training provided shall include practical and theoretical training.
- (d) Training shall be conducted in a language and method appropriate for the workforce.
- (e) Refresher training shall be provided at appropriate intervals and include the criteria listed in Section 2(b) of this Cop.
- (f) Employers shall maintain a record of the required training that contains the following:
- (i) name and ID number;
 - (ii) Emirates ID number of the employee;
 - (iii) subject(s) of training;
 - (iv) date(s) of training; and
 - (v) person providing the training;
- (g) Employers shall provide appropriate information, instruction and /or training to those persons who are not at work, but are at risk from noise levels emitted from the workplace.
- (h) Employers shall ensure that any contractors who are working within the workplace, and are exposed to noise levels at or above an 8-hr time weighted average of 85 dB(A) have received appropriate training.

3. Requirements

3.1 Roles and Responsibilities

3.1.1 Employers

- (a) Employers shall undertake their roles and responsibilities in accordance with the general requirements of *OSHAD-SF – Element 1 – Roles, Responsibilities and Self-Regulation Section 3.2.5*.
- (b) Employers shall eliminate noise hazards by purchasing low noise and vibration producing equipment, maintaining equipment to manufacturer's specifications, erecting barriers, or implementing other control measures to eliminate / reduce noise hazards, where reasonably practicable.
- (c) Employers shall provide protection to employees, contractors and visitors against the effects of noise exposure when the sound levels exceed those shown in Appendix 1 when measured on the A scale of a standard sound level meter at slow response. When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined using the procedure found in Appendix 2.
- (d) Employers shall, when employees are subjected to exposure levels exceeding those listed in Appendix 1, implement reasonably practicable engineering and/or administrative control measures. If such control measures fail to reduce sound levels within the levels of Appendix 1, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

Note: If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous.
- (e) Employers shall ensure employees, contractors and visitors are not be exposed to any continuous, intermittent, or impact noise levels at or in excess of a 100 dB(A), unless the appropriate hearing protection is provided.
- (f) Employers shall develop and implement a "Hearing Conservation Program" as per Section 3.3 of this CoP when they have noise hazards that exceed 85 dB(A).

3.1.2 Employees

- (a) Employees shall undertake their roles and responsibilities in accordance with the general requirements of *OSHAD-SF – Element 1 – Roles, Responsibilities and Self-Regulation Section 3.2.7*.
- (b) Employees shall report any activity or equipment defect relating to noise exposures which they believe is reasonably practicable to cause any overexposure to themselves or another person.
- (c) Employees shall use appropriate hearing protection, equipment or safety devices provided by the employer in accordance with any training or instruction received.

3.2 Noise Risk Assessment

- (a) Employers who carry out work which is liable to expose any employees to noise at or above the action level of 85 dB(A) shall make a suitable and sufficient assessment of the risk, in line with the requirements of *OSHAD-SF - Element 2 – Risk Management*, from that noise to the safety and health of those employees, and the risk assessment shall identify the measures which need to be taken to meet the requirements of this CoP. Employers shall also assess exposure to any contractors or other persons that may be affected by the noise emissions of the workplace.
- (b) When undertaking the noise risk assessment, the employer shall assess the levels of noise to which workers are exposed by:
 - (i) observation of specific working practices;
 - (ii) reference to relevant information on the probable levels of noise corresponding to any equipment used in the particular working conditions; and
 - (iii) if necessary, measurement of the level of noise to which his employees are likely to be exposed.
- (c) Employers shall assess whether any employees are likely to be exposed to noise at or above the exposure limits as detailed in Appendix 1 of this document.
- (d) The risk assessment shall consider:
 - (i) the level, type and duration of exposure, including any exposure to peak sound pressure;
 - (ii) the effects of exposure to noise on employees or groups of employees whose health is at particular risk from such exposure;
 - (iii) so far as is practicable, any effects on the health and safety of employees resulting from the interaction between noise and the use of ototoxic substances at work, or between noise and vibration;
 - (iv) any indirect effects on the health and safety of employees resulting from the interaction between noise and audible warning signals or other sounds that need to be audible in order to reduce risk at work;
 - (v) any information provided by the manufacturers of work equipment;
 - (vi) the availability of alternative equipment designed to reduce the emission of noise;
 - (vii) any extension of exposure to noise at the workplace beyond normal working hours, including exposure in rest facilities supervised by the employer;
 - (viii) appropriate information obtained following health surveillance, including, where possible, published information; and
 - (ix) the availability of personal hearing protectors with adequate attenuation characteristics.
- (e) The risk assessment shall be reviewed on a regular basis, at least annually and following any significant changes within the workplace likely to affect the noise levels employees are exposed to.

3.3 Hearing Conservation Program

- (a) Employers shall administer a continuous, effective hearing conservation program, as described in this section whenever noise exposures, as identified through a noise risk assessment described in section 3.2 of this document, equals or exceed 85 decibels measured on the A-weighted scale (slow response). For the purposes of the hearing conservation program, employee noise exposures shall be computed in accordance with Appendix 1 and/or Appendix 3, and without regard to any attenuation provided by the use of personal protective equipment. Employers shall ensure no employee, contractor or other person is exposed to any continuous, intermittent, or impact noise at or in excess of 100dB(A) without the use of hearing protection.
- (b) Employers hearing conservation programs shall consist of the following elements:
- (i) exposure monitoring:
1. employers shall use a competent person to develop and implement a monitoring program and sampling strategy to assess employee's exposure to noise;
 2. the sampling strategy shall be designed to identify employees for inclusion in the hearing conservation program and to enable the appropriate selection of hearing protection;
 3. where circumstances such as high employee 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 paragraph unless the employer can show that area sampling produces equivalent results;
 4. all continuous, intermittent and impulsive sound levels from 80 dB(A) to 130 dB(A) shall be integrated into the noise measurements;
 5. instruments used to measure employee noise exposure shall be calibrated as per manufacturer's recommendations to ensure measurement accuracy;
 6. monitoring shall be repeated whenever a change in production, process, equipment or control measures increases 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 Section 3.3(b)(xii) of this CoP.
- (ii) employee notification:
1. employers shall notify each employee exposed at or above an 8-hour time-weighted average of 85 dB(A) of the results of the monitoring. Notification shall be made in the language and method understood by the employee.

(iii) audiometric testing program:

1. employers shall establish and maintain an audiometric testing program as provided in this paragraph by making audiometric testing available to all employees whose exposures equal or exceed an 8-hour time-weighted average of 85 dB(A);
2. the audiometric testing program shall be provided at no cost to the employees; and
3. audiometric tests shall be performed by a licensed or certified audiologist, otolaryngologist, or other physician, or by a technician that is certified/accredited by DOH and who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and appropriately using, maintaining and checking calibration and appropriate functioning of the audiometers being used. A technician who performs audiometric tests shall be responsible to an audiologist, otolaryngologist or physician.

(iv) baseline audiogram:

1. within 6 months of an employee's first exposure at or above 85 dB(A) of noise, the employer shall establish a valid baseline audiogram against which subsequent audiograms can be compared;
2. testing to establish a baseline audiogram shall be preceded by at least 14 hours without exposure to workplace noise. Hearing protectors may be used as a substitute for the requirements that the baseline audiograms be preceded by 14-hours without exposure to workplace noise; and
3. employers 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.

(v) annual audiogram:

1. within 12 months of an employee's baseline audiogram, the employer shall provide an audiogram that can be compared to the baseline audiogram and subsequent audiograms;
2. testing to establish an annual audiogram shall be preceded by at least 14 hours without exposure to workplace noise. Hearing protectors may be used as a substitute for the requirements that the baseline audiograms be preceded by 14-hours without exposure to workplace noise; and
3. employers 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.

(vi) evaluation of audiogram:

1. each employee's 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 as defined by Section 3.3(b)(viii) of this CoP;
2. if the annual audiogram shows that an 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 they shall determine whether there is a need for further evaluation. The employer shall provide to the person performing this evaluation the following information:
 - a copy of the requirements of this CoP;

- the baseline audiogram and most recent audiogram of the employee to be evaluated;
- measurements of background sound pressure levels in the audiometric test room as required in Section 3.5 of this document; and
- records of audiometric calibrations as required by the equipment manufacture.

(vii) follow-up procedures:

1. if a comparison of the annual audiogram to the baseline indicates a standard threshold shift as defined in Section 3.3(b)(viii) of this document, the employee shall be informed of this fact in writing, in a language the employee will understand, 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 the following steps are taken when a standard threshold shift occurs:
 - employees shall be fitted/refitted with hearing protectors, trained in their use and care, and required to use them;
 - hearing protection in use shall be evaluated to ensure they are offering the appropriate attenuation. If necessary, hearing protectors shall be replaced with hearing protectors offering greater attenuation;
 - employees shall be referred for a clinical audio-logical evaluation or an otological examination, as appropriate, if additional testing is necessary or if the employer suspects that the medical pathology of the ear is affected or aggravated by the wearing of hearing protectors; and
 - 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 indicates that a standard threshold shift is not persistent, the employer shall inform the employee of the new audiometric interpretation.

(viii) standard threshold shift:

1. as per this CoP, a standard threshold shift is a change in hearing threshold relative to the baseline audiogram of an average of 10 dB(A) or more at 2000, 3000, and 4000 Hz in either ear; and
2. in determining whether a standard threshold shift has occurred, no allowance shall be made for the contribution of aging (presbycusis).

(ix) audiometric test requirements:

1. audiometric tests shall be pure tone, air conduction, hearing threshold examinations, with test frequencies including as a minimum 500, 1000, 2000, 3000, 4000, and 6000 Hz. Tests at each frequency 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 in accordance with, *American National Standards Institute S3.6-2010* or *International Standards Organization 8253-1:2010*;
3. pulsed-tone and self-recording audiometers, if used, shall meet the requirements specified in Section 3.5 of this CoP; and

4. audiometric examinations shall be administered in a room meeting the requirements listed in Section 3.6 of this CoP.
- (x) audiometric calibration:
1. the functional operation of the audiometer shall be checked before each day's use in accordance with manufacturer's specifications. If no specification exists, the audiometer shall be checked by testing a person with known, stable hearing thresholds, and by listening to the audiometer's output to make sure that the output is free from distorted or unwanted sounds. Deviations of 10 dB(A) or greater require an acoustic calibration;
 2. audiometric calibration shall be checked annually in accordance with manufactures specifications. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this check. Deviation of 15 dB(A) or greater require an exhaustive calibration; and
 3. an exhaustive calibration shall be performed at least every two years in accordance with manufacturer's specifications and *American National Standards Institute S3.6-2010* or *International Standards Organization 8253-1:2010*. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this check.
- (xi) hearing protectors:
1. employers shall make hearing protectors available to all employees exposed to an 8-hour time-weighted average of 85 dB(A) or greater at no cost to employees. Hearing protectors shall be replaced as necessary;
 2. employers shall require all employees exposed to an 8-hour time-weighted average of 85 dB(A) or greater to wear hearing protection;
 3. employees shall be given the opportunity to select their hearing protectors for a variety of appropriate hearing protectors provided by the employer;
 4. employers shall provide training in the use and care of all hearing protectors provided to employees; and
 5. employers shall make sure that the hearing protectors provided to employees shall fit the employee correctly and provide the required protection.
- (xii) hearing protector attenuation:
1. employers shall evaluate hearing protector attenuation for the specific noise environments in which the protector shall be used. The employer shall use one of the evaluation methods described in Section 3.8 of this document;
 2. hearing protectors shall attenuate employee exposure at least to an 8-hr time-weighted average of 85 dB(A);
 3. in the event hearing protectors cannot be purchased with an attenuation rating that shall bring the exposure below an 8-hr time-weighted average of 85 dB(A), double protection (both muffs and plugs) shall be worn. Employers shall calculate the rating for the double hearing protection using the requirements of Section 3.8(b) of this document. Double hearing protectors shall attenuate employee exposure at least to an 8-hr time-weighted average of 85 dB(A); and
 4. the appropriateness of hearing protector attenuation shall be re-evaluated whenever employee noise exposures increase to the extent that the hearing protectors provided no longer provide appropriate attenuation. The employer shall provide more effective hearing protection where necessary.

3.4 Noise Hazard Signage

- (a) Employers shall post warning signs in each work area where the noise levels are or exceed 85 dB(A) notifying employees and visitors that hearing protection is required if entering or working in the area. If double hearing protection is required, this shall be identified on the warning sign.
- (b) Signs shall be in the language of employees entering the area. Signs shall comply with *OSHAD-SF – CoP 17.0 – Safety Signage and Signals*.

3.5 Audiometric Measuring Instruments

- (a) In the event that pulse-tone audiometers are used, they shall have a tone on-time of at least 200 milliseconds.
- (b) Self-recording audiometers shall comply with the following requirements:
 - (i) the chart upon which the audiogram is traced shall have lines at positions corresponding to all multiples of 10 dB(A) hearing level within the intensity range spanned by the audiometer. The lines shall be equally spaced and shall be separated by at least 1/4 inch. Additional increments are optional. The audiogram pen tracings shall not exceed 2 dB(A) in width;
 - (ii) it should be possible to set the stylus manually at the 10 dB(A) increment lines for calibration purposes;
 - (iii) the slewing rate for the audiometer attenuator shall not be more than 6 dB(A)/sec except that an initial slewing rate greater than 6 dB(A)/sec is permitted at the beginning of each new test frequency, but only until the second subject response;
 - (iv) the audiometer should remain at each required test frequency for 30 seconds (+ or - 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 + or - 3 seconds; and
 - (v) it shall be possible at each test frequency to place a horizontal line segment parallel to the time axis on the audiogram, such that the audiometric tracing crosses the line segment at least six times at that test frequency. At each test frequency the threshold shall be the average of the midpoints of the tracing excursions.

3.6 Audiometric Test Rooms

- (a) Rooms used for audiometric testing shall not have background sound pressure levels exceeding those in Table 3.1 when measured by equipment conforming at least to the Type 2 requirements of *American National Standard Specification for Sound Level Meters, S1.4-1983 (R2006)*, and to the *Class II requirements of American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters, S1.11-2004 (R2009)*.

Octave-band center frequency (Hz)	500	1000	2000	4000	8000
Sound pressure level (dB)	40	40	47	57	62

Table 3.1 – Maximum Allowable Octave-Band and Sound Pressure Levels for Audiometric Test Rooms

3.7 Computation of Employee Noise Exposure

- (a) The sound pressure level shall be determined by a sound level meter or dosimeter conforming, as a minimum, to the requirement of the *American National Standards Institute (ANSI) Specification for Sound Level Meters, S1.4-1983 (R2006)*, Type S2A, or *ANSI S1.25-1991 (R2007) Specification for Personal Noise Dosimeters*. The measurement device shall be set to use the A-weighted network with slow meter response. The duration of exposure shall not exceed that shown in Appendix 1. These values apply to the total duration of exposure per working day regardless of whether this is one continuous exposure or a number of short-termed exposures.
- (b) A sound calibrator shall be used for direct calibration of sound level meter or dosimeter before and after noise measurements. The sound calibrator shall comply with:
- (i) *EN/IEC 60942 (2003) Class LS and Class 1*; and/or
 - (ii) *ANSI S1.40-1984*.
- (c) Sound level meters and dosimeters shall be calibrated by the manufacturer or a manufacturer approved third party organization according to manufacturer's specifications.
- (d) Occupational noise exposure assessments shall be completed in accordance with this CoP.
- (e) When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect shall be considered rather than the individual effect of each.
- (f) When sound level meter or dosimeter readings equal or exceed 85 dB(A), employers shall calculate the allowable noise using the calculation found in Appendix 3.

3.8 Computation of Hearing Protection Attenuation

- (a) Calculating single hearing protection device (plugs or muffs):

(An example of how to perform this calculation can be found in Appendix4.)

- (i) when calculating the hearing protection attenuation, the employer shall take the noise reduction rating (NRR) stated by the manufacture of the hearing protection and subtract 7dB(A) from the rating; and
 - (ii) the calculated hearing protection attenuation shall then be subtracted from the worksite sound level measured with a sound level meter or dosimeter on the A-weighted scale. If the calculated exposure is below 85 dB(A), the hearing protection shall be determined to be appropriate.
- (b) Calculating double hearing protection (plugs and muffs) - When a single hearing protection device is not sufficient to protect an employee for a noise hazard, and double protection (plugs and muffs) is required, the hearing protection attenuation shall be calculated in the following manner:

(An example of how to perform this calculation can be found in Appendix 4.)

- (i) calculate the hearing protection attenuation for the plugs as stated in Section 3.8(a);
- (ii) calculate the hearing protection attenuation for the muffs by subtracting 25% of the manufacture rated NRR. If the calculation gives you a decimal, round down to nearest whole number;
- (iii) add the calculated attenuation for the plugs and muffs together to get the total attenuation; and
- (iv) the calculated total hearing protection attenuation shall then be subtracted from the worksite sound level measured with a sound level meter or dosimeter on the A-weighted scale. If the calculated exposure is below 85 dB(A), the double hearing protection shall be determined to be appropriate.

4. Record Keeping

- (a) Exposure monitoring, medical surveillance, examination and consultation records shall be kept for a minimum of period of employment plus 30 years, as per *OSHAD-SF – Element 9 – Compliance and Management Review*.
- (b) All compliance and training records shall be kept for a minimum of five (5) years, as per *OSHAD-SF – Element 9 – Compliance and Management Review*.

5. References

- *OSHAD-SF – Element 1 – Roles, Responsibilities and Self-Regulation*
- *OSHAD-SF – Element 9 – Compliance and Management Review*
- *OSHAD-SF – CoP 17.0 – Safety Signage and Signals*
- *2010 TLVs and BEIs – American Conference of Governmental Industrial Hygienists.*
- *Health and Safety Executive, Statutory Instruments 2005 No.1643, Health and Safety – The Control of Noise at Work Regulations 2005*
- *U.S. Occupational Safety and Health Administration, 29 CFR 1910.95 – Occupational Noise Exposure*
- *American National Standards Institute (ANSI) Specification for Sound Level Meters, S1.4-1983 (R2006), Type S2A*
- *American National Standards Institute (ANSI) S1.25-1991 (R2007) Specification for Personal Noise Dosimeters*
- *NIOSH Publication No. 98-126, Criteria for a Recommended Standard: Occupational Noise Exposure*
- *American National Standards Institute (ANSI) - Measurement of Occupational Noise Exposure, ANSI S12.12-1996 (ANSI 1991a)*

6. Document Amendment Record

Version	Revision Date	Description of Amendment	Page/s Affected
3.0	1 st July 2016	Change of Logo	All
		Change from AD EHS Center to OSHAD	throughout
		Change of document title: AD EHSMS RF to OSHAD-SF	Throughout
		Acknowledgements deleted	2/3
		Preface Deleted	4
		EHS changes to OSH	throughout
		Clause 3.1.1(a) added	5
		Addition of section 3.2 – adding requirements for a noise risk assessment	5
		Clarify scope to include employee's contractors and visitors	Throughout
		Training record requirements expanded	3
		Training requirements for visitors and contractors added	3/4
		Noise action levels clarified to read "equals or exceeds"	throughout
		<i>"as identified through a noise risk assessment described in section 3.2 of this document" added to Clause 3.3(a) to clarify the need for a hearing conservation program</i>	7
3.1	10 th June 2018	Minor editorial changes without changing requirements	Throughout
		Reference to ANSI standard ANSI S12.12-1996 updated	15
		Appendix 4 – Title updated	21
		Appendix 4 – Exposure calculations updated	21

APPENDIX 1: Allowable Duration of Exposure Based on Sound Level dB(A)

مستوى التعرض	الفترة الزمنية			مستوى التعرض	الفترة الزمنية		
Exposure Level, L	Duration, T			Exposure Level, L	Duration, T		
(dBA)	Hours	Minutes	Seconds	(dBA)	Hours	Minutes	Seconds
80	24	-	-	106	-	3	45
81	20	10	-	107	-	2	59
82	16	-	-	108	-	2	22
83	12	42	-	109	-	1	53
84	10	5	-	110	-	1	29
85	8	-	-	111	-	1	11
86	6	21	-	112	-	-	56
87	5	2	-	113	-	-	45
88	4	-	-	114	-	-	35
89	3	10	-	115	-	-	28
90	2	31	-	116	-	-	22
91	2	-	-	117	-	-	18
92	1	35	-	118	-	-	14
93	1	16	-	119	-	-	11
94	1	-	-	120	-	-	9
95	-	47	37	121	-	-	7
96	-	37	48	122	-	-	6
97	-	30	-	123	-	-	4
98	-	23	49	124	-	-	3
99	-	18	59	125	-	-	3
100	-	15	-	126	-	-	2
101	-	11	54	127	-	-	1
102	-	9	27	128	-	-	1
103	-	7	30	129	-	-	1
104	-	5	57	130-140	-	-	<1
105	-	4	43	-	-	-	-

A person shall not be exposed to any continuous, intermittent, or impact noise levels above 100 dB(A), unless the appropriate hearing protection is provided.

APPENDIX 2: Calculating dB(A) Using Octave Band Analysis Data

When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined using the following procedure:

Step 1: The A-weighting corrections given in Table A shall be added or subtracted arithmetically to each octave band sound pressure level;

Step 2: The A-corrected band levels shall be converted into arbitrary intensity units “I” using Table B;

Step 3: The values of “I” shall be added together arithmetically;

Step 4: The total value of “I” shall be converted into A-weighted sound level, dB(A), using Table B. When the total value of “I” falls between two values in the table, take the next higher value of sound level.

Octave band center frequency Hz	63	125	250	200	1000	2000	4000	8000
A-weighting correction dB	-26	-16	-9	-3	0	+1	+1	-1

Table A

dB	0	1	2	3	4	5	6	7	8	9
60	.0010	.0013	.0016	.0020	.0025	.0032	.0040	.0050	.0063	.0079
70	.010	.013	.016	.020	.025	.032	.040	.050	.063	.079
80	.100	.126	.158	.200	.251	.316	.398	.501	.631	.794
90	1.00	1.26	1.58	2.00	2.51	3.16	3.98	5.01	6.31	7.94
100	10.0	12.6	15.8	20.0	25.1	31.6	39.8	50.1	63.1	79.4
110	100	126	158	200	251	316	398	501	631	794

Table B

Example Problem:

The first two columns in the table below show the octave band sound pressure level measured in each octave band center frequency. Column three shows the A-weighting corrections taken from Table A as required in Step1 above, and column four gives the A-corrected octave band. The A-corrected octave band levels are converted into “I” values using Table B as required in Step 2 above. Column 5 shows the “I” value for each frequency, which is then added together as required in Step 3 above. The total value for “I” is then converted into an A-weighted sound level value using Table B, as required in Step 4 above.

1 Octave band center frequency HZ	2 Octave band sound pressure level dB	3 A-weighting correction from Table A dB	4 A-corrected octave band level dB	5 “I” value from Table B
125	95	-16	79	0.079
250	102	-9	93	2.000
500	105	-3	102	15.800
1000	102	0	102	15.800
2000	98	+1	99	7.940
4000	89	+1	90	1.000
8000	79	-1	78	0.063

- Total value of “I” = 42.682
- From Table B the nearest A-weighted sound level to the nearest decibel, as required by Step 4 above = 107 dB(A)

APPENDIX 3: Calculation of Allowable Noise:

T = reference duration corresponding to the measured sound level

L = sound level measured in decibels (A-weighted sound level)

$$T = \frac{8}{2^{(L-85)/3}}$$

Example:

You measure a sound level of 94dB(A), what is the length of exposure allowed before 8-hr time-weighted average of 85 dB(A)?

$$T = \frac{8}{2^{(94-85)/3}} \quad T = 1 \text{ hr}$$

You are allowed one hour of exposure before you shall exceed the 8-hr time-weighted average of 85 dB(A).

Note: This is the same as found in Appendix 1.

Calculation of total noise exposure (dose) shall be done using the following calculation:

D = noise dose (less than 1 = no overexposure and greater than 1 = overexposure)

C = total time of exposure at a specific noise level

T = reference duration corresponding to the measured sound level

** see above calculation or Appendix 1.

$$D = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \dots + \frac{C_n}{T_n}$$

Example:

You measure a sound level of 88dB(A) for 2 hours, 91dBA for 30 min, and 85dB(A) for 3 hours. Have you exceeded the allowed 8-hr time-weighted average of 85 dB(A)?

$$T_{88} = 4\text{hrs}, T_{91} = 2\text{hrs}, T_{85} = 8\text{hrs}$$

$$C_{88} = 2\text{hrs}, C_{91} = 0.5\text{hrs}, C_{85} = 3\text{hrs}$$

$$D = \frac{2}{4} + \frac{0.5}{2} + \frac{3}{8} = 1.125$$

Since D is greater than one (1.125) you have exceeded the 8-hr time-weighted average of 85 dB(A).

APPENDIX 4: Computation of Hearing Protection Attenuation

Calculating Single Hearing Protection Device (Plugs or Muffs):

When calculating the hearing protection attenuation, the employer shall take the noise reduction rating (NRR) stated by the manufacture of the hearing protection and subtract 7dB from the rating.

The calculated hearing protection attenuation shall then be subtracted from the worksite sound level measured with a sound level meter or dosimeter on the A-weighted scale. If the calculated exposure is below 85 dB(A), the hearing protection shall be determined to be appropriate.

Example:

- Noise monitoring determines a level of 94 decibels on the A-weighted scale.
- Hearing protection is rated by the manufacture to have a NRR of 28dB
- Hearing Protection Attenuation = $28\text{dB} - 7\text{dB} = 21\text{dB}$
- Employee exposure with hearing protection = $94\text{dB(A)} - 21(\text{NRR}) = 73\text{dB(A)}$
- The hearing protection is appropriate to protect employees.

Calculating double hearing protection (plugs and muffs):

When a single hearing protection device is not sufficient to protect an employee for a noise hazard, and double protection (plugs and muffs) is required, the hearing protection attenuation shall be calculated in the following manner:

- (i) Calculate the hearing protection attenuation for the plugs as stated above for single hearing protection device.
- (ii) Calculate the hearing protection attenuation for the muffs by subtracting 25% of the manufacture rated NRR. If the calculation give you a decimal, round down to nearest whole number.
- (iii) Add the calculated attenuation for the plugs and muffs together to get the total attenuation
- (iv) The calculated total hearing protection attenuation shall then be subtracted from the worksite sound level measured with a sound level meter or dosimeter on the A-weighted scale. If the calculated exposure is below 85 dB(A), the double hearing protection shall be determined to be appropriate.

Example:

- Noise monitoring determines a level of 125 decibels on the A-weighted scale.
- Hearing protection for plugs is rated by the manufacture to have a NRR of 34dB
- Hearing protection attenuation for plugs = $34\text{dB} - 7\text{dB} = 27\text{dB}$
- Hearing protection for muffs is rated by the manufacture to have a NRR of 25dB.
- Hearing protection attenuation for muffs:
 - 25% of 25dB = 6.25dB
 - Attenuation for muffs = $25\text{dB} - 6.25\text{dB} = 18.75\text{dB}$ (round 18.75 dB down to 18dB)
- Attenuation for double hearing protection = $27\text{dB} + 18\text{dB} = 45\text{dB}$
- Employee exposure with double hearing protection = $125\text{dB(A)} - 45(\text{NRR}) = 80\text{dB(A)}$
- The double hearing protection is appropriate to protect employees.

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