

Hearing Conservation Program

Guideline for Noise Exposure

Environmental Health and Safety Office
September 7th, 2017

1.0 INTRODUCTION

1.1 Purpose

The hearing conservation program is intended for all workers, students, contractors, and all other persons who may work in an environment considered hazardous to their hearing and includes conditions produced by research activities. The purpose of the hearing conservation program is to identify all spaces on campus where a noise hazard is present in order to mitigate risks.

For all employee health-related concerns, noise dosimetry testing information, noise dosimetry testing requests, information on hearing protection, or information on Ontario legislation, please contact the Environmental Health and Safety Office.

1.2 Noise Hazards

Noise is one of the most common physical hazards present in the occupational setting. The risk associated with exposure to noise depends on three main components: 1) the frequency of the sound wave, 2) the amplitude of the sound wave, and 3) the duration of exposure. These three factors can vary substantially depending on the occupational setting. For instance, in heavy industrial or manufacturing environments hearing loss may pose as the main health concern. Whereas, in noisy offices, classrooms et cetera, the noise may provide an annoyance and interfere with communications.

1.3 Noise Exposure and Hearing Loss

Exposure to elevated levels of noise may result in three main adverse auditory effects: tinnitus (ringing in the ears), temporary hearing loss, and permanent hearing loss. Temporary hearing loss (also known as a temporary threshold shift) occurs immediately after exposure to a high level of noise. A person can recover from this type of hearing loss relatively quickly (hours) as soon as the person removes themselves from the area and goes to a quiet area. Conversely, permanent hearing loss (also known as a permanent threshold shift) will progress with consistent exposure to high levels of noise.

It is important to note that this noise induced hearing loss creates permanent and irreversible hearing damage. There are two types of hearing damage: 1) conductive hearing loss, and 2) sensorineural hearing loss. Conductive hearing loss deals with mechanical damage to a portion of the ear (i.e., tympanic membrane or hammer). Sensorineural hearing loss involves the inner ear and is most often the result of the hair cells within the cochlea becoming injured, losing function or dying. Therefore, repeated elevated exposures can lead to a permanent threshold shift which would create irreversible sensorineural hearing loss.

It is noted that hearing loss also has causes that are not associated directly to occupational noise exposure, such as: 1) environmental or recreational noise, 2) combined exposure with certain physical or chemical agents, and 3) aging. Environmental or recreational noise may be in the

form of loud music, power tools, or driving on the highway. Also, certain physical or chemical agents (i.e., vibration, organic solvents, carbon monoxide) appear to have synergistic effects when combined with noise exposure on hearing loss. Lastly, some sensorineural hearing loss occurs naturally with aging (presbycusis).

1.3.1 Sound Pressure and Sound Pressure Levels

Sound is the result of air pressure changes in the form of sound waves that are interpreted as sound. As these sound waves or pressure changes reach the human ear, they stimulate specialized cells within the inner ear that convert vibrations into signals to be processed by the brain. Sound waves with differing frequencies and wave amplitude produce different sounds.

Noise decays exponentially with distance as the sound wave loses energy; therefore, the farther away from the noise source the quieter it will be. It is important to note that the sound pressure will also depend on the environment in which the source is located. For instance, hard surfaces reflect sounds and noise will be louder if you are in a closed room compared to an open-field. Lastly, sound pressures can cover a broad range of intensity and as such sound pressure is converted to a decibel scale (a logarithmic scale) and is termed sound pressure level when compared to a reference sound pressure.

2.0 ONTARIO LEGISLATION

Requirements for sound levels in the workplace are covered in [Ontario Regulation 381/15](#), under the [Occupational Health and Safety Act](#).

You can also view this legislation at www.e-laws.gov.on.ca

2.1 Definition

Decibel: a unit of measurement of sound pressure level that is equal to 20 times the logarithm to the base 10 of the ratio of the pressure of a sound, divided by the reference pressure of 20 micropascals.

dB(A): a measure of sound level in decibels using a reference sound pressure of 20 micropascals when measured on the A-weighting network of a sound level meter.

2.2 Measurement

Workplace sound levels are measured in decibels on the A-weighting network; this network closely resembling human hearing.

To calculate an equivalent sound level, the following formula is used:

$$L_{\text{ex},8} = 10 \text{ Log}_{10} \left(\frac{\left[\sum_{i=1}^n (t_i \times 10^{0.1 \text{ SPL}_i}) \right]}{8} \right)$$

Where:

- L_{ex,8}* the equivalent sound exposure level in 8 hours,
- S* the sum of the values in the enclosed expression for all activities from *i* = 1 to *i* = *n*,
- i* a discrete activity of a worker exposed to a sound level, *t_i* is the duration in hours of *i*,
- SPL_i* the sound level of *i* in dBA,
- n* is the total number of discrete activities in the worker's total workday.

2.3. Ontario Regulation 381/15: Overview

- Section 2(1)* Employers must take all measures reasonably necessary to protect workers from exposure to hazardous sound levels.
- Section 2(2)* Employers must follow the hierarchy of controls (first use engineering controls, then work-practices, then PPE).
- Section 2(3)* Any measurement of sound levels in the workplace that is conducted to determine which protective measures are appropriate shall be conducted without regard to any use of personal protective equipment.
- Section 2(4)* Every employer shall ensure that no worker is exposed to a sound level greater than or equivalent to 85 dB(A) *L_{ex,8}*.

In Ontario, an “equivalent exposure” is based on a 3 decibel exchange rate. This means that when a given exposure time period is cut in half, the allowable exposure level is increased by 3 decibels. Please see Table 1 below for the relationship between exposure time and decibel level.

Table 1: Noise exposure-duration limits

Exposure Time	Allowable Decibel Level (dBA)
16 hours	82
8 hours	85
4 hours	88
2 hours	91
1 hour	94
30 minutes	97
15 minutes	100

Section 2(6) Whenever possible, employers shall protect workers by using engineering controls rather than using personal protective equipment.

If engineering controls are:

- a. Not in existence or not obtainable
- b. Are not reasonable or not practical to adopt, install or provide because of the duration or frequency of the exposure or because of the nature of the process, operation or work
- c. Are rendered ineffective because of a temporary breakdown of such controls
- d. Are ineffective to prevent, control or limit exposure because of an emergency

Workers shall wear and use hearing protection devices appropriate in the circumstances to protect them from exposure to a sound level greater than the limit.

Section 2(7) A clearly visible warning sign shall be posted at all approaches to an area where the sound level **regularly** exceeds 85 dB(A).

3.0 NOISE SAMPLING METHODS

The Environmental Health and Safety Office at Carleton is equipped with a Svantek 104A noise dosimeter. This device can either be used as a personal noise dosimeter or a general sound level meter. If used as a personal noise dosimeter, the microphone is attached to the workers shoulder (closest to the ear) as they perform a specific noise hazardous task. This means the device can be worn for task-specific duration, or a full shift. When the device is used as a sound level meter, the microphone is directed towards certain areas in a workplace where the noise hazard may

exist. This gives a general noise reading of the work environment otherwise known as noise mapping surveys.



Figure 1: Svantek 104A noise dosimeter

The microphone captures the sound level and records it for a given time period, after which the data can be downloaded and the results can be evaluated through numerous charts and graphs. The most applicable function of this device is its ability to generate the user's time-weighted average (TWA) for an exact time period. The TWA is measured in dBA, and can be used to determine if a worker needs hearing protection throughout their tasks. The Svantek 104A device is calibrated before and after each test to ensure that the results are as accurate as possible. The device is also laboratory calibrated annually.

4.0 HEARING PROTECTION DEVICES (HPDs)

As indicated in Section 2(6) of O.Reg 381/15, hearing protection devices are considered a last resort for worker protection. This is because HPDs do not remove the hazard; rather, they protect a single worker; provided that an ear insert (plug) or other HPD is worn correctly. HPDs come in a variety of shapes, styles, and types. At Carleton University ear plugs and ear muffs are most commonly used. The noise reduction ratings (NRRs) of HPDs vary depending on make and model with most falling between 25-30dB.

NRR values are C-weighted, and not de-rated, therefore it is not accurate to simply subtract the noise levels by the NRRs. The NRR must be converted to A-weighting, which is done by subtracting the NRR by 7, then multiplying by 0.75 for ear muffs and 0.5 for earplugs to account for fitting and use limitations. Therefore it is important to note that the noise hazard levels often are only reduced by 7-12dBA when wearing HPDs.



Figure 2: 3M Peltor Optime ear muffs and North Com-fit earplugs

Areas on campus indicated as having noise levels that regularly exceed 85 dBA (see Appendix), there should either be a set of ear muffs or a box of packaged earplugs available for use. In most cases, they will be in a small box mounted on a wall or placed on a shelf. Should you notice that one of the boxes is empty, or that no HPDs are available to use at a given location, please notify your supervisor.

All hearing protection devices must be CSA approved.

*****Please note that personal audio devices, such as iPods and MP3 players, do NOT provide suitable hearing protection.**

5.0 TRAINING

Prior to a worker or user receiving and wearing a hearing protection device, a supervisor must provide this person with instructions on how to properly use and install the HPD. Ear muffs are much simpler to use as they simply placed on the ears and adjusted via the head strap. Ear plugs must be rolled to fit the user's entrance to their ear canal. The supervisor must also explain the device's limitations and why the HPD is required in certain areas.

Information about these devices is typically available from the manufacturer or on the supplier's website. A [video illustrating how to fit foam earplugs](#) is available on YouTube.

For additional information on training requirements, sample presentations and other materials, please contact the Environmental Health and Safety Office.

6.0 SIGNAGE

As indicated in section 2(7) of O.Reg 381/15, a clearly visible warning sign shall be posted at all approaches to an area where the sound level **regularly** exceeds 85 dB(A) (including research activities).

Carleton University currently has a pre-defined template for these signs. A picture of the sign is shown below.



Figure 3: Carleton's Signage for Noise Hazardous Areas

7.0 HEALTH CONCERNS

Workers who have health concerns which they believe may be related to their work environment are encouraged to discuss these concerns with their supervisor. Any health effect(s) or symptom(s) related to employment (noise or otherwise) must be reported to the Environmental Health and Safety office. Further assessment of the workplace may be required.

The table below, which was originally developed by the Canadian Centre for Occupational Health and Safety (CCOHS), gives an indication of how much noise is typical of a given environment.

Table 2: Typical noise levels in specific environments

Table 2 Typical Noise Levels	
Noise Source	dB(A)
Pneumatic chipper at 1m	115
Hand-held circular saw at 1m	115
Textile room	103
Newspaper press	95
Power lawn mower at 1m	92
Diesel truck 50 km/h at 20m	85
Passenger car 60 km/h at 20m	65
Conversation at 1m	55
Quiet room	40

8.0 EQUIPMENT AND MECHANICAL ROOMS

As part of the University’s hearing conservation program, the Environmental Health and Safety Office audits suspected areas for potential noise hazards. Focus is placed on areas that are suspected of regularly exceed 85 dB. These areas include mechanical rooms, maintenance spaces, as well as research and academic workshops. The results of the latest noise survey can be found in Appendix.

It is incumbent on the supervisor to identify the potential hazard, assess the risk, and institute proper controls to mitigate the hazard. Of particular note, while you may not be generating a hazardous noise level, other persons working in the area may be conducting work that produces the hazardous noise level and control measures may be required nonetheless. If there is a noise concern for a workspace or task, request a noise assessment by contacting the Environmental Health and Safety Office.

9.0 ADDITIONAL RESOURCES

Additional resources are available from the following organizations:

Canadian Centre for Occupational Health and Safety

- [OSH answers: noise - auditory effects](#)

Workplace Safety and Insurance Board

- [Noise-Induced Hearing Loss](#)

Appendix - Noise Survey Results

Building	Room	Date	Noise Source	#	Sound Level (dBA)		HPD Required ¹	Signage
					Idling/ Ambient	Equipment in Use		
Architecture	220	10-Jul-17	Ambient Noise		72-74		No	Installed
		10-Jul-17	Small CNC Router	1	87.9	96.9	Yes	
		10-Jul-17	Radio Arm Saw	1	96.4	102.9	Yes - Double	
		10-Jul-17	Dewalt Saw (Welding Room)	1	98	105	Yes - Double	
		10-Jul-17	Angle Grinder (Welding Room)	1	98	102.6	Yes - Double	
		10-Jul-17	Welding Hammering	1	N/A	97-102	Yes - Double	
Architecture	214	11-Jul-17	Ambient Noise		77-87		No	Installed
		11-Jul-17	Belt Sander	1	90.2	92.7	Yes	
		11-Jul-17	Spindle Sander	1	87	92	Yes	
		11-Jul-17	Disc Sander	1	93.1	101.3	Yes - Double	
		11-Jul-17	Band Saw	3	87.3	91.4	Yes	
		11-Jul-17	Planar	1	95.9	99.2	Yes	
		11-Jul-17	Thickness Planar	1	93.1	95.6	Yes	
		11-Jul-17	Miter Saw	2	97.5	102.2	Yes - Double	
		11-Jul-17	Table Saw	1	89.9	95.5	Yes	
Architecture	233	17-Jul-17	Dust Collector	1	N/A	81-95	Yes	Installed
		17-Jul-17	Large CNC Router (with Dust collector on)	1	92.2	98.2	Yes	
Dunton Tower	115 (chiller)	20-Jul-17	Ambient Noise		78-89		Yes	Installed
Canal Building	Tunnel (chiller)	20-Jul-17	Ambient Noise		92-96		Yes	Installed
Loeb Building	1st Floor (chiller)	21-Jul-17	Ambient Noise		85-93		Yes	Installed

HCI/VSIM	1st Floor (chiller)	21-Jul-17	Ambient Noise		79-85		No	Installed
MacOdrum Library	3rd Floor Parking Garage (chiller)	21-Jul-17	Ambient Noise		87-93.5		Yes	Installed
Tory Building	180A (chiller)	21-Jul-17	Ambient Noise		88-91		Yes	To Be Installed
Lennox-Addington House	1st Floor (chiller)	21-Jul-17	Ambient Noise		84-91.5		Yes	Installed
St. Patrick's	1st Floor Next to Tunnel (chiller)	21-Jul-17	Ambient Noise		80-90		Yes	Installed
Maintenance Building	138	18-Jul-17	Ambient Noise		84-91		Yes	Installed
Maintenance Building	38	18-Jul-17	Fan # 1	1	N/A	89.1	Yes	Installed
		18-Jul-17	Fan # 2	1	N/A	94.0 - 98.7	Yes	
Maintenance Building	39	18-Jul-17	Fan # 3	1	N/A	96.3 - 102	Yes	Installed
Maintenance Building	112	26-Jul-17	Water Jet	1	N/A	89.5	Yes	To Be Installed
Grounds	Butler Building	12-Jul-17	EQ21 - Kubota B-3000	1	87.3	88.9	Yes	To Be Installed
		12-Jul-17	EQ08 - Kubota F2260	1	90	93.5	Yes	
		12-Jul-17	EQ07 - Kubota	1	89.3	95	Yes	
		12-Jul-17	EQ22 - Kubota	1	91.9	93.2	Yes	
		12-Jul-17	EQ16 - Bobcat	1	82.5	86.3	Yes	
		12-Jul-17	String trimmer	8	100	108.6	Yes - Double	

Herzberg	1119	10-Nov-14	Ambient Noise		81		No	Installed
		14-Nov-17	Rock Saw	3	N/A	89-91	Yes	
		14-Nov-17	Trim Saw	1	N/A	93	Yes	
		14-Nov-17	Small Crusher	2	N/A	82	No	
Ice House	1443	22-Jun-17	Ambient Noise		59-65		No	Installed
		22-Jun-17	Zamboni	2	N/A	90.4	Yes	
		22-Jun-17	Edger	6	N/A	94.2	Yes	
Ice House	1445A	22-Jun-17	Compressors (Ice chiller Room)	3	N/A	89.0 - 93.1	Yes	Installed
Minto CASE	4088	14-Jul-17	General Area		79.6		No	Not Required
Minto CASE	1074	26-Jul-17	Ambient Noise (Chiller Room)		85-86	87-91.8	Yes	To Be Installed
Minto CASE	4074	14-Jul-17	General Area		76.9		No	Not Required
Minto CASE	4070	14-Jul-17	General Area		76.1		No	Not Required
Minto CASE	4090	14-Jul-17	General Area		67.2		No	Not Required
Minto CASE	4086	14-Jul-17	General Area		65.9		No	Not Required
Minto CASE	4082	14-Jul-17	General Area		70.4		No	Not Required
Minto CASE	4072	14-Jul-17	General Area		66		No	Not Required
		14-Jul-17	With Pump On		78.9		No	Not Required
Minto CASE	4074	14-Jul-17	General Area		86		No	To Be Installed
Minto CASE	5041B	14-Jul-17	General Area		67.6		No	Not Required
Minto CASE	5033D	14-Jul-17	General Area		68.2		No	Not Required
Minto CASE	5033C	14-Jul-17	General Area		70.1		No	Not Required
Minto CASE	5033A	14-Jul-17	General Area		67.4		No	Not Required
Minto CASE	5033B	14-Jul-17	General Area		70.5		No	Not Required

Mackenzie	2157	11-Jul-17	Ambient Noise		65-70		No	Installed
		11-Jul-17	CNC -Larger	1	77.5	83.3	No	
		11-Jul-17	Router Table	1	86.5	92.2	Yes	
		11-Jul-17	Spindle Sander	1	95.7	100.1	Yes	
		11-Jul-17	Engine Lathe	1	78.7	79.2	No	
		11-Jul-17	Dewalt Miter Saw	1	102.4	117.2	Yes - Double	
		11-Jul-17	Bosch Table Saw (Portable)	1	93.2	98.7	Yes	
		11-Jul-17	Extraction Arm Ventilator	2	N/A	82.3	No	
		11-Jul-17	Angle Grinder		103.8	105.1	Yes - Double	
Mackenzie	Mechanical rooms	20-Jul-17	Ambient Noise		65-77		No	Installed
Herzberg	Mechanical rooms	20-Jul-17	Ambient Noise		65-75		No	Installed
Architecture	Mechanical rooms	20-Jul-17	Ambient Noise		65-72		No	Installed
Dunton Tower	23rd & 24th floor	20-Jul-17	Ambient Noise		65-75		No	Installed

- Note:**
1. Where double hearing protection is noted as 'Yes', a review of frequency and duration of use should be completed to determine its requirement.
 2. Double Hearing Protection involves the use of both earplugs and ear muffs whereas hearing protection constitutes as ear muffs OR ear plugs.