HEARING CONSERVATION PROGRAM

Contents

1.0 Purpose

The purpose of this document is to provide a framework to prevent occupational noise-induced hearing loss (NIHL) and/or other complications of work-related noise exposure over time.

2.0 Scope

This program applies to all work conducted at any campus owned or operated by the University of Waterloo. It also includes work that is conducted off-site as part of University-sanctioned work or research.

Nuisance noise (see definitions) is out of scope for this program.

3.0 Definitions

The following terms are defined to facilitate comprehension of this document. These terms are used throughout this program.

Action Limit
An action limit is a threshold value which when reached indicates exposure to a hazardous substance is close to a harmful level. Reaching an action limit requires initiation of specific actions to assess and control risk. For noise exposures at UW, the action limit is 82 dB(A), and once reached requires that an assessment of the noise exposure is performed by the Safety Office to determine signage, controls and training requirements.

dB
Decibel. The dB is a logarithmic and dimensionless unit for measuring sound pressure levels.

dB(A)
A-weighted decibel. The dB(A) is a decibel scale used because it closely represents the way the human ear responds to noise.

Exchange rate
The increase in sound level for which permissible exposure time is halved, or the decrease in sound level for which permissible exposure time is doubled. In Ontario, the exchange rate is 3 dB. For example, if the maximum allowable exposure to an 85 dB noise is eight hours, then the exchange rate tells us that the maximum allowable exposure to an 88 dB noise is 4 hours and the maximum allowable exposure to an 82 dB noise is 16 hours.

Equivalent sound exposure level (L_{eq})
The continuous sound pressure level of noise averaged over a period of time which contains the same amount of energy as that generated by the actual and varying sound levels being measured. Because occupational noise is complex and worker

exposure may fluctuate throughout the work shift, the sound levels need to be averaged over a sample period that is representative of the entire exposure. $\mathbf{L_{ex,8}}$ is the equivalent sound exposure level ($\mathbf{L_{eq}}$) of noise averaged over 8 hours, the length of a typical work shift.

HCP
Hearing Conservation Program

Impact noise
A very short burst of loud noise followed by a period of quiet. Examples include gun shots, hammering, a punch press, or cymbals. Impact noise events last for less than one second and are separated from the next event by at least half a second (CCOHS - Noise).

NIHL
Noise-induced hearing loss

Noise
In general, noise is defined as any unwanted sound. Noise control measures in UW's Hearing Conservation Program target noise levels and noise exposures which are associated with noise-induced hearing loss (refer to the definitions for 'noise-exposed' and 'noise hazard area' for clarification).

Noise dosimetry
A noise assessment technique that involves placing a noise recording device onto an individual to record and calculate their noise exposure for the duration of their shift. The device will take the recorded values and calculate the equivalent 8-hour exposure value for that individual which can be compared to the occupational exposure limit. It is particularly useful when employees work in a variety of noisy areas for short durations at a time or perform different noisy operations on any given day.

Noise surveys
An analysis of noise in a defined area. A noise survey is a spatial map of noise values that are generated within a workspace. It is a snapshot in time that provides a good basis to understand the noise exposures expected for anyone entering or working within that space. A good noise survey will indicate how measurements were taken and what equipment was operational during the survey. At UW, noise surveys are initiated when a worker or supervisor identifies a space that may have potentially elevated noise levels.

Noise Reduction Rating (NRR)
A single number rating that indicates the overall hearing protector attenuation, used to evaluate the effectiveness of hearing protection devices.

Nuisance noise
Noise which may be irritating or annoying to some people but is not loud enough to be hazardous or associated with noise-induced hearing loss. Examples include road traffic, barking dogs, background music, office equipment, or even verbal speech.

OHSA
Occupational Health and Safety Act

Time-weighted average (TWA)
The time-weighted average is a measure of the average noise exposure over a typical 8-hour workday, taking into account the exchange rate and ignoring measurements below an identified cut-off level (UW's noise assessment uses an exchange rate of 3dB, and no threshold).

4.0 Roles and Responsibilities

At the University of Waterloo, the following individuals have specific roles in this program.

4.1 Department Heads

Department heads shall provide appropriate resources to evaluate, assess and control noise exposures as required.

4.2 Supervisors

- Identify work environments and processes that may expose workers to excessive noise and report these to the Safety Office for further review.
- Verify workers who may perform work that exposes them to noise above the legislated occupational exposure limit (OEL) have been trained on the hazards and harms of being exposed to excessive noise.
- Maintain procedures that specify what controls are required to reduce risk to hazardous noise.
- Implement noise controls where exposures may become hazardous.
- Enforce the requirement for workers under their supervision to follow procedures, use controls, and use PPE that is designed to minimize hazardous noise exposures.

4.3 Safety Office

- Provide noise assessment consultation services to departments where hazardous noise exposure may be present.
- Develop and maintain an online training course on the harms of hazardous noise exposures and the various controls and PPE that can be used to mitigate these risks.

4.4 Workers/Students

- Report any noise related hazards to their supervisor for review.
- Follow procedures, use controls, and wear PPE as prescribed.

5.0 Noise Hazards

Noise exposure is likely to cause harm when it exceeds a time-weighted average of 85 dB(A). The two steps used to understand what noise hazards exist at the University of Waterloo include:

- Identifying noise hazards
- Assessing noise hazards

5.1 Identifying Noise Hazards

The Safety Office will identify locations, processes and tools that may generate elevated levels of noise.

Examples of work or work locations that may generate elevated levels of noise include:

- Mechanical rooms and electrical rooms that include compressors and/or HVAC systems
- Vehicle workshops
- Shop tools such as drill presses, grinding wheels, and powered saws.
- Tools powered by compressed air such as impact wrenches
- Outdoor lawn and grounds maintenance equipment

Once identified, these items are matched to occupations or locations so assessment of noise exposures can be made. The Safety Office will review hazard reports which identify locations or work that has the potential to cause noise exposure.

5.2 Assessing Noise Hazards

At the University, noise hazards are quantified through one or a combination of the following methods:

- Noise surveys (see definitions)
- Noise dosimetry (see definitions)

These methods are used to determine when and what controls must be used to reduce employee exposure risks to occupational noise hazards.

**To capture variations in noise levels, The University's action limit is 82 dB(A).*

6.0 Legislative Requirements

In Ontario, prevention of hazardous noise exposure is primarily outlined in the Occupational Health and Safety Act (OHSA) and in Ontario's Noise regulation, O. Reg 381/15. This legislation outlines what the occupational exposure limit is for noise, what actions shall be taken by the employer and by workers. This is summarized below:

- The occupational exposure limit (OEL) for noise in Ontario is 85 dB(A) Lex,8.

- Signage shall be placed at every entry way into work areas known to have sound levels above 85 dB(A). This signage shall warn people that sound levels in the area are at or above 85 dB(A).
- Workers shall not be exposed to noise at or above 85 dB(A) Lex,8 without adequate control measures in place to reduce the worker's noise exposure level below this threshold.
- Controls shall be implemented in order of most effective to least effective, with PPE being considered the least effective control.
- If the workplace prescribes hearing protection to be worn, workers must wear this PPE as prescribed.
- The employer must train workers on the selection, use and care of hearing protection devices and other types of hearing controls that are implemented.

**Note - To capture variations in noise levels, UW's action limit for further investigation is 82 dBA.*

7.0 Control Measures

In the workplace, Ontario Regulation 381/15, specifies an OEL of 85 dBA as measured over an 8-hour workday. UW compares measured exposure levels to this OEL, and when (or has the potential to be) exceeded, will implement controls in the order of the Hierarchy of Controls.

The Hierarchy of Controls is a method of categorizing controls by effectiveness. The effectiveness of a control decreases the further it gets from the source; therefore those applied at the source of noise (Engineering e.g., isolation) are more effective than those applied to a person (PPE e.g., ear plugs).

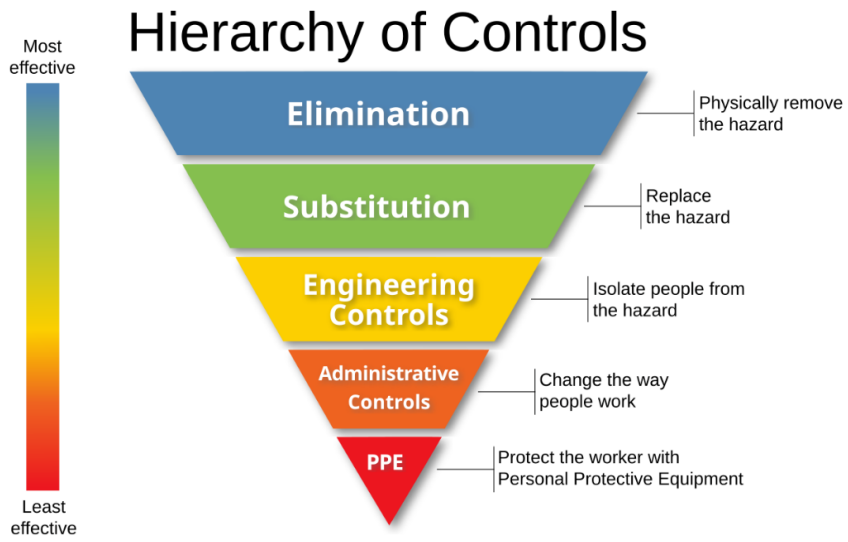

Figure 1: Hierarchy of Controls model

7.1 Elimination

Elimination of hazards is the most effective type of control, but for noise management it is difficult to implement as it involves removing the process, tools, or equipment.

7.2 Substitution

Substitution involves replacing the hazardous item with something less hazardous. For noise, that would involve replacing devices that generate noise with ones of similar function that generate less noise. An example of this would be to replace gas-powered equipment with battery-powered equipment, e.g., battery powered weed trimmers, leaf blowers, and lawn mowers.

7.3 Engineering

Noise generated from machinery and equipment comes from one or more of the following:

1. Mechanical impacts
2. High velocity fluid flow
3. Vibrating surfaces of machinery

7.3.1 Mechanical Impacts

Impact noise reduces if energy used in the system is decreased. As an example, for processes which involve dropping items from height, reducing the height or cushioning the fall of the items will reduce impact noises (Figure 2).

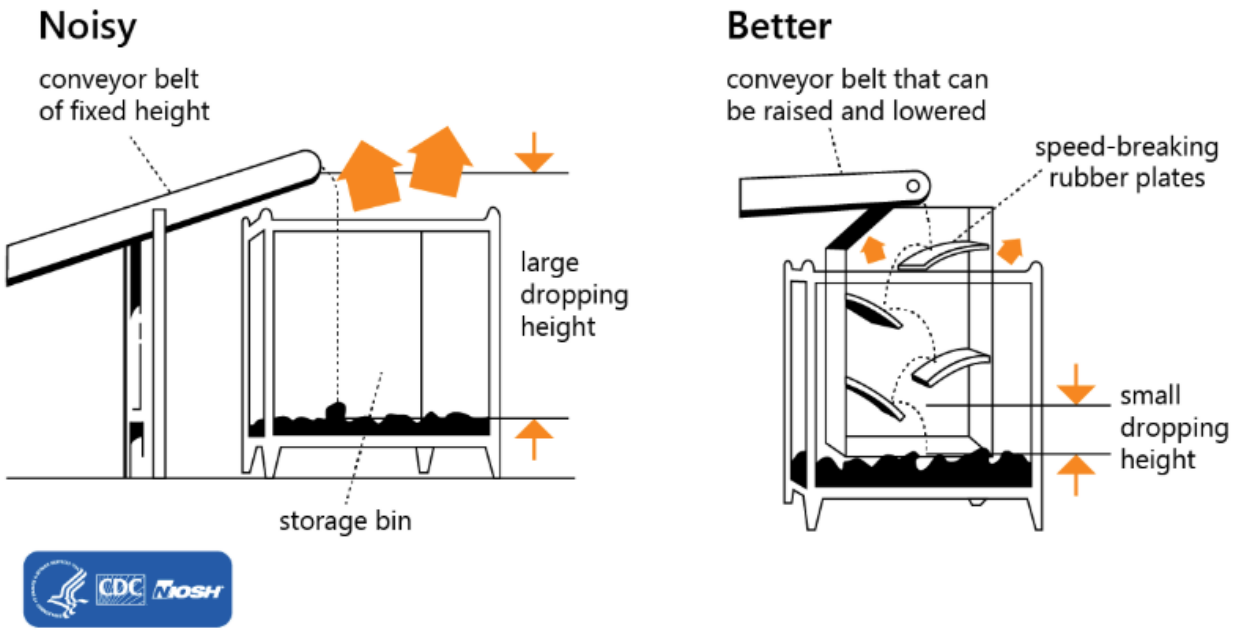

Figure 2: Illustration of how modifications of drop distance may reduce noise generation. Accessed May 8, 2025 from the CDC.

7.3.2 High Velocity Fluid Flow

Fluid in this sense means gases (e.g., air) and liquids. Fluid flowing at high velocities can generate noise. To reduce this noise in pipe distribution systems, the following design considerations should be followed:

- Eliminate restricted flow, avoid restricted flow transitions.
- Locate control valves in straight pipes.
- Locate all L's and T's at least 10 pipe diameters downstream of valves.
- Pipe cross-section reducers and expanders should be at an included angle of 15 to 20 degrees.
- Limit fluid flow to 30 ft/sec for liquids.
- Maintain laminar flow, avoid turbulent flow.
- Use flex connectors or vibration or acoustical isolation to reduce vibratory transfer to pipe walls.
- Optimize energy by reducing fluid flows, fan speeds, etc.

7.3.3 Vibrating Surfaces of Machinery

It is rare to have industrial machinery or tools that do not vibrate in some form or fashion. However, determining if that vibration causes occupationally hazardous noise and requires intervention is not straight forward. For this reason, preventative maintenance is the normal first step to identify if machinery/tools should undergo an analysis. If equipment is identified as needing analysis, it should be undertaken by a knowledgeable noise professional.

Two types of vibratory intervention include vibration damping and vibration isolation.

Vibration damping is the reduction of amplitude of a vibration which involves attaching an energy dissipating material on one or both sides of a vibrating surface. Common types of machinery or tools that are common candidates for vibratory interventions include:

- Thin metal machine casings or panels
- Metal wall enclosures
- Fan and blower housings
- Gear box casings

A note of caution – prior to installing damping material, compatibility must be verified for the device itself and for the work environment/operating conditions (temperature, humidity, chemicals, etc.).

Vibration isolation involves removing the direct connection between the source of noise and surfaces that may transmit that noise (floors, walls, ceilings). This is normally done

with metal springs, elastomeric mounts, and resilient pads. Figures 3 and 4 below illustrate this concept.

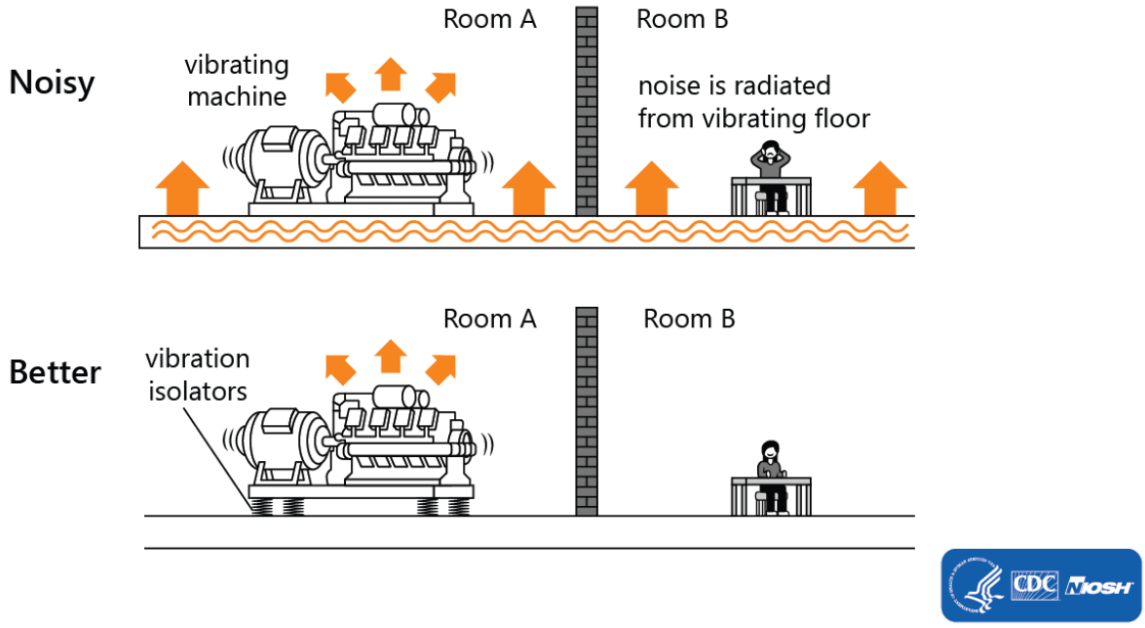

Figure 3: Example of how including changing mounts to isolate machinery can reduce the transmission of noise. .Accessed May 8, 2025 from the CDC.

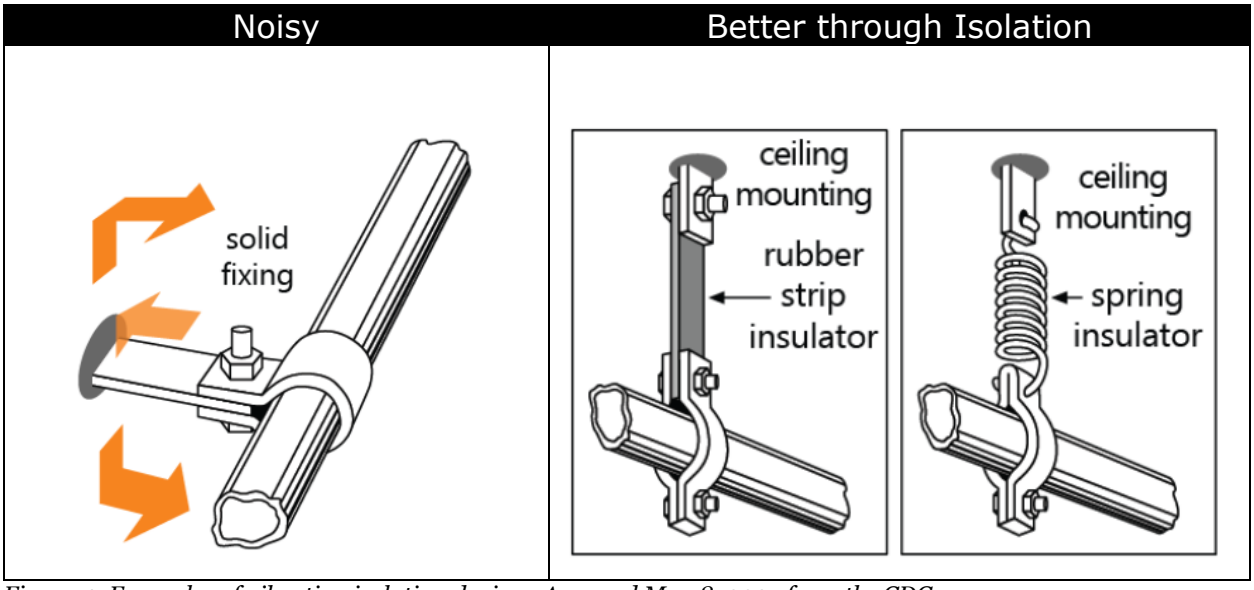

Figure 4: Examples of vibration isolating devices. Accessed May 8, 2025 from the CDC.

7.3.4 Using Absorptive Materials, Enclosures and Acoustical Barriers

Sound reflects easily off hard surfaces, such as walls, ceilings and floors. Reflecting sound can combine with the source sound and creating significantly higher noise exposures. One method of reducing this is utilizing sound absorptive materials.

Sound absorptive materials are porous and thick and include foams and textiles. Covering hard surfaces can reduce reflective sound, reducing overall noise levels.

If the need for access by a worker to a device is minimal, the device may be enclosed to isolate noise from the workers or areas. Enclosures are built of heavy and dense materials with very poor sound transmission properties. Enclosures can be used for single pieces of equipment or groups of equipment generating the noise. Advantages of using enclosures include high sound attenuation (20 to 40 dB) across a wide range of frequencies, easy to install and relatively affordable.

When a full enclosure is impractical, a partial partition may be erected between the source of noise and the receiver. These are called acoustical barriers, and they are generally most effective under the following conditions:

- Barriers should be located as close to the source or user as possible.
- The wider the barrier the better, with it being at least 2x as wide as its height.
- Height should be as high as practicable.
- Sound transmission loss of the panel should be at least 10 dB greater than what is needed.
- The barrier should be solid, without any gaps.
- Barriers are better for high-frequency sounds, as low frequency sounds tend to travel around barriers.
- Barriers are most effective for worker(s) exposed to direct sound. If worker(s) are affected by reflected sound barriers may not be as effective.
- Sound absorptive materials are included on ceilings or walls to prevent or minimize reflected sound (Figure 5).

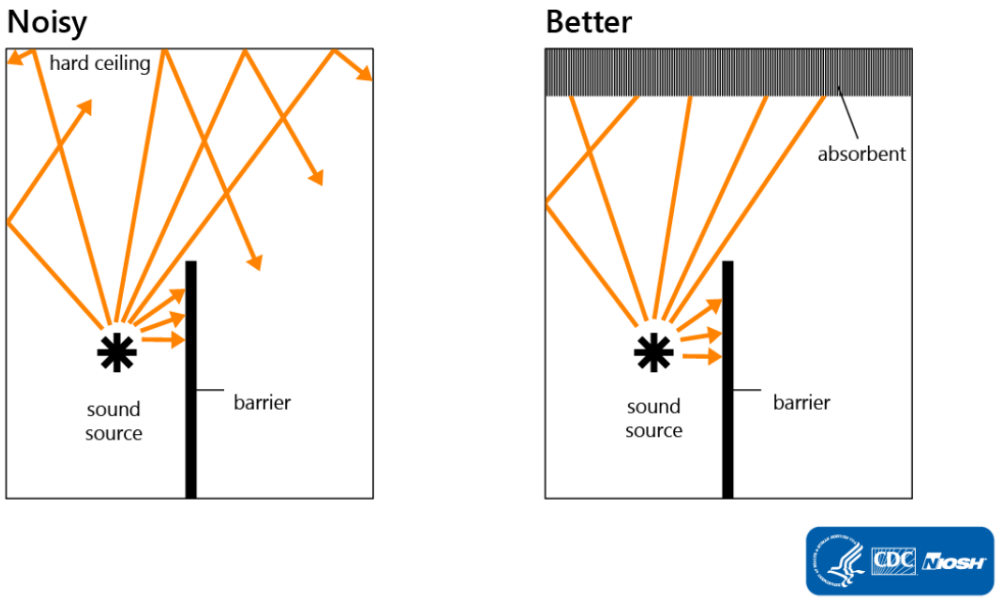

Figure 5: Use of acoustical barriers and absorbent materials on ceiling. Accessed May 8, 2025 from the CDC.

7.4 Administrative Controls

Administrative controls include changes to how people work to reduce the duration, frequency and/or severity of the hazard. In some situations, this means rotating employees through high exposure work or tools; or by limiting when certain work is performed. Other administrative controls include providing instruction through training and standard operating procedures. This allows for better clarity on how the work should be performed to minimize hazardous exposures and to use available controls in the most effective manner possible.

7.5 Personal Protective Devices – Hearing Protection Devices

Supervisors will provide compliant Hearing Protection Devices (HPDs) when required. Common types of HPDs provided are earplugs and earmuffs. Devices used must comply with the CSA Standard Z94.2-14 “Hearing Protection Devices – performance, selection, care and use.”

Hearing Protection Devices (HPD) are categorized and labeled according to a particular Class and/or Noise Reduction Rating (NRR). This is related to the attenuation of the HPD, which is the anticipated level of protection at the ear that would be provided by a properly functioning and fitted device. Both of these methods are considered in the selection of HPD.

7.5.1 HPD – Definitions

Class

The assignment of class to an HPD is the result of octave-band attenuation values measured in accordance with CSA Standard Z94.2-14, according to a defined attenuation range. The class is identified on packaging as (A/AL, B/BL, or C).

Noise reduction rating (NRR)

Also known as NRR, describes how well the hearing protection device will reduce the noise entering the ear. It is commonly listed on the package of hearing protectors. The NRR is generally an overestimation of the protection provided by the hearing protectors, which should be considered when selecting PPE.

General use guidelines include the following:

- Manufacturer's instructions for use should be followed.
- Inspect the device regularly for wear and tear. Replace as needed.
- Always ensure a tight seal with the ear canal or against the side of the head is achieved.
- When handling and fitting HPDs, ensure that both the device and your hands are clean.
- When reusable HPDs are chosen, proper storage in a clean, suitable environment is critical.

More information on the selection of Hearing Protection Devices can be found at CCOHS – Personal Protective Equipment.

8.0 References

1. Health, Safety & Well-being, "Hearing Conservation Program", University of Western, London, 2024. Accessed May 7, 2025 [Online]. Available: https://www.uwo.ca/hr/form_doc/health_safety/doc/procedures/hearing_protection_program.pdf
2. "Occupational Health & Safety Act", Publications Ontario [Online]. Available: https://www.ontario.ca/laws/statute/90001 [Accessed : May 8, 2025]
3. Occupational Health Clinics of Ontario workers Inc., "Noise Induced Hearing Loss", OHCOW [Online]. Available: https://www.ohcow.on.ca/occupational-illness-2/exposures/noise-induced-hearing-loss-nihl/ [Accessed: May 7, 2025]
4. "Ontario Regulation 381/15: Noise" Publications Ontario [Online]. Available:

   https://www.ontario.ca/laws/regulation/150381 [Accessed : May 2, 2025]
5. Ontario, "A guide to the Noise Regulation under the Occupational Health and Safety Act", Regulation [Online]. Available: https://www.ontario.ca/document/guide-noise-regulation-under-occupational-health-and-safety-act/regulation. [Accessed : May 8, 2025]
6. Canadian Centre for Occupational Health and Safety, "Noise", CCOHS [Online]. Available: https://www.ccohs.ca/oshanswers/phys_agents/noise [Accessed: May 8, 2025]
7. Canadian Centre for Occupational Health and Safety, "Personal Protective Equipment", CCOHS [Online]. Available: https://www.ccohs.ca/oshanswers/prevention/ppe [Accessed: May 5, 2025]
8. CDC National Institute for Occupational Safety and Health (NIOSH), "Implement Engineering Controls", Noise and Hearing Loss [Online]. Available: https://www.cdc.gov/niosh/noise/prevent/engineering.html. [Accessed : May 2, 2025
9. Occupational Safety and Health Administration, "Noise", OSHA Technical Manual (OTM) Section III: Chapter 5 [Online]. Available: https://www.osha.gov/otm/section-3-health-hazards/chapter-5. [Accessed : May 6, 2025]

9.0 Record of Revisions

Date	Author/Editor	Change	Version
May 2025	Dhananjai Borwankar	▪ Program release	Hearing Conservation Program v.1.0 MAY2025