Hearing Conservation

Work Aid – Rev. 12 (January 2024)

Office of the Chief Risk Officer

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Contents

Version Control Table

Version Number	Owner	Approver	Change Summary	Status
12	OCRO	OCRO	Document review	Approved

1. Document Background

Purpose and scope of document

This document is a supplement to the Occupational Health and Safety Management System program manuals and procedures, with focus on hearing conservation. It is intended for workers, students, and any individuals who may be exposed to potentially hazardous noise levels in their work environment, including those generated during research activities.

For all worker-related concerns, or for audiometric testing information, please contact the Health and Wellness Sector, Human Resources.

For inquiries about basic sound level testing, information on hearing protection devices, or information about Ontario legislation, please speak to your supervisor or contact the Office of the Chief Risk Officer.

Terms and definitions

Refer to the OHS Glossary for the OHS terms and definitions that apply to documents within the management system.

Additional terms and definitions specific to this procedure are listed below.

Decibel – a unit of measurement of sound pressure level, equivalent to 20 times the logarithm 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.

Continuous noise – sound that has unbroken sound waves.

Intermittent noise – sound that has broken or interrupted sound waves.

Noise – unwanted sound. Sound, like water, travels in waves; it is similar to dropping a rock in the middle of a still body of water: the waves (of sound or water) ripple outward from the source.

Sound – oscillations in pressure above and below ambient atmospheric pressure.

Responsibilities

With respect to this work aid, the responsibilities of supervisors and workers are detailed in the health and safety program manuals as well as Administrative Procedure 14-1.

In addition to the roles and responsibilities outlined in Procedure 14-1, additional responsibilities specific to this procedure are listed in:

Reference documents

- Occupational Health and Safety Act
- Ontario Regulation 381/15
- General OHS Program Manual

- Hazard Identification and Risk Assessment Procedure

2. Resource Information

Hearing Conservation Steps

The following steps support hearing conservation and the use of hearing protection devices:

1. Understanding hearing conservation requirements
2. Understanding the anatomy of the ear and auditory health effects
3. Assessing and measuring risk
4. Referring at-risk workers to specialists for audiograms
5. Implementing reasonable mitigation measures

Additional steps may be required based on the project or scope of work.

STEP 1 Understanding hearing conservation requirements

Key activities

- Be familiar with Ontario Regulation 381/15.
- Identify and assess areas of risk.

Contextual details

Regulation 381

Regulation 381 sets out the requirements to protect workers from noise hazards according to the *Occupational Health and Safety Act*. For the purposes of the Regulation, an employer shall ensure that no worker is exposed to a sound level greater than an equivalent sound exposure level of 85 dB(A).

In Ontario, an "equivalent exposure" is based on a 3-decibel exchange rate. This means that when a given exposure time is halved, the allowable exposure level is increased by 3 decibels.[1] Refer to the chart below for a comparison.

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

1 Ministry of Labour, Immigration, Training and Skills Development – Appendix B – Determining Noise Exposure and Calculating Lex,8.

Where a worker is exposed to continuous noise throughout their shift, the exposure duration must not exceed the value for that sound level in the table above. Once the worker has reached the allowable duration for that sound level, the worker's noise exposure has reached 100% of the permissible daily noise dose. For example, if a worker is exposed to a steady sound level of 91 dBA, the maximum permissible daily exposure duration is two hours. Multiple different sound levels may culminate and exceed a daily dose.

If engineering controls are:

a. Not available or not obtainable;
b. Unreasonable or impractical to implement, install, or provide due to the frequency, duration, or nature of the exposure, process, operation, or work;
c. Rendered ineffective due to a temporary breakdown of such controls; or
d. Ineffective in preventing, controlling or limiting exposure during an emergency,

workers shall wear and use hearing protection devices suitable for the given circumstances to protect themselves from exposure to sound levels exceeding the established limit.

Warning signs must be posted in areas where noise approaches hazardous levels.

STEP 2 Understanding the anatomy of the ear and auditory health effects

Key activities

- Understand basic ear anatomy.
- Understand the possible hearing-related health effects of noise.
- Refer workers for audiograms, where applicable.

Anatomy

The ear has three major parts: the outer, middle, and inner ear[2]. The **outer ear,** which consists of the ear lobe, collects sound vibrations and directs the sound toward the eardrum. The **middle ear** converts mechanical vibrations in the air into fluid vibrations. The middle ear consists of the:

- Ossicle (which includes the incus, stapes, and malleus);
- Eustachian tube, which equalizes pressure between the middle and outer ear;
- Oval window; and
- Round window.

The **inner ear** changes the mechanical waves in liquid into chemical impulses that are sent to the brain. The inner ear consists of the cochlea and the organ of Corti, which is the essential receptor end organ for hearing, and contains the hair cells.

Auditory Health Effects

The main auditory effects of noise include[3]:

2 Yates, David A. Safety Professional's Reference and Study Guide; 2nd edition; 272.
3 CCOHS – Noise – Auditory Effects – December 2023.

- **Acoustic trauma –** sudden hearing damage caused by short burst of extremely loud noise, such as a gun shot.
- **Tinnitus –** ringing or buzzing in the ear.
- **Temporary hearing loss** – also known as temporary threshold shift (TTS), which occurs immediately after exposure to a high level of noise. There is gradual recovery when the affected person spends time in a quiet place. Complete recovery may take several hours or days (up to 48 hours).
- **Permanent hearing loss** – permanent hearing loss, also known as permanent threshold shift (PTS), usually progresses constantly as chronic noise exposure continues year after year. Most individuals do not notice the impairment at first. The hearing impairment is noticeable only when it is substantial enough to interfere with routine activities. At this stage, permanent and irreversible hearing damage has occurred. Noise-induced hearing damage cannot be cured by medical treatment and worsens as the noise exposure continues. When the noise exposure stops, the person does not regain the lost hearing sensitivity. As the employee ages, hearing may worsen as age-related hearing loss adds to the existing noise-induced hearing loss. Permanent hearing loss can also occur from a single traumatic event.

Types of hearing loss

There are different types of hearing loss, which are briefly listed below.[4]

- Conductive: occurs in the outer and middle ear; is the loss of "loudness".
- Sensorineural: occurs in the inner ear, affecting the hair cells responsible for hearing
- Mixed: A combination of both conductive and sensorineural hearing loss.
- Central nervous system occurs between the inner ear and the brain and may results from causes unrelated to noise exposure.
- Psychogenic: occurs in the brain and may be linked to psychological trauma.

Major causes of hearing loss

Cause of hearing loss may be related to:

- Obstruction or foreign body in the ear
- Disease
- Acoustic trauma (acute or chronic)
- Presbycusis (age-related hearing loss)
- Sociocusis (socially related hearing loss)
- Noise-induced (acute or chronic).

Health concerns

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

4 Yates, David A. Safety Professional's Reference and Study Guide; 2nd edition; 272-273

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

Noise Source	dB(A)
Pneumatic chipper at 1 metre	115
Hand-held circular saw at 1 metre	115
Textile room	103
Newspaper press	95
Power lawn mower at 1 metre	92
Diesel truck 50 km/h at 20 metres	85
Passenger car 60 km/h at 20 metres	65

STEP 3 Assessing and measuring risk

Key activities

- Conduct preliminary qualitative survey of workspace to identify areas of potentially hazardous noise
- Identify legislative, institutional, and manufacturer requirements for the work, including for hearing-related risks.
- Define appropriate measures to effectively eliminate or mitigate identified hazards and risks.

Assessing

If the hazard(s) of the specific work or area have not been previously assessed by completing a HIRA or equipment/activity specific procedure (that includes the outcome of a HIRA), conduct a HIRA with reference to the Hazard Identification and Risk Assessment Procedure.

Measuring

Workplace sound levels are measured in decibels on the A-weighting network; this network closely resembles human hearing. To calculate an equivalent sound level, use the following formula:

$$L_{ex,8} = 10\log_{10}\left(\frac{[\sum_{i=1}^{n}(t_i * 10^{0.1*SPL_i})]}{8}\right)$$

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

The Office of the Chief Risk Officer is equipped with a basic sound level meter and with a noise dosimeter. Both devices are equipped with pre-set calibrators and are briefly described below.

REED SL-4012 Sound Level Meter
This device is a single-measurement digital instrument used to obtain an instant reading of the sound level in the given area. It can also capture the minimum and maximum sound levels within a given time period. This device is used primarily for area samples.

Quest Noise-Pro DL Dosimeter
This device is intended to be worn by a worker during a pre-set period (usually an entire shift) with the recording device positioned near the user's ear to capture the user's exposure to noise over the period. The microphone captures the sound level and records it for the entire period, after which the data can be downloaded and the results evaluated. The most useful function of this device is its ability to generate the user's time-weighted average for an exact period.

Smartphone hardware and applications have advanced considerably in recent years and can provide a rough estimate of noise levels; however, they should not be relied upon for quantitative assessments.

Building inventory

As part of a hearing conservation program, we completed an assessment of large buildings on campus (e.g., those with larger, noisier mechanical rooms). Noise levels in mechanical rooms in small houses on King Edward, Laurier, Stewart, Séraphin-Marion, etc. would not be expected to regularly reach or exceed 85 dB(A), therefore these areas were not included in the assessment. Areas in which noise levels exceed 80 dB(A) are identified with warning signs.

Noise levels are not limited solely to physical environments, such as mechanical rooms. Research and support workspaces also have the potential to reach hazardous noise levels. It is incumbent on the supervisor to identify the potential hazard, assess the risk, and institute proper measures to mitigate the risk.

A person may request a noise assessment of their work area at any time by reporting to their supervisor. The Office of the Chief Risk Officer may be contacted to assist, as necessary.

STEP 4 Referring at-risk workers to specialists for audiograms

An audiogram is a personal medical surveillance test that is strongly recommended for those who work in traditionally "noisy" areas or who may have cause to work in noisy areas as part of their normal duties (including research activities). These individuals may include, but are not limited to:

- mechanics
- plumbers
- power plant workers
- electricians
- architectural or construction tradespeople
- project managers
- animal care and veterinary service workers
- information technology workers
- workshop and laboratory technicians and/or managers

The purpose of the audiometric evaluation is to establish a baseline and identify the potential progression of work-related hearing loss so that preventive measures can be implemented. It also serves to identify temporary hearing loss before it becomes permanent. The WSIB has made an example tool available online.

Audiometric testing is conducted by a certified audiologist. Appointments are scheduled through Health and Wellness. Test results are confidentially shared with the worker only. We recommend that at-risk workers undergo an audiogram at the start of their employment at the University (i.e., within the first six months), and then every two years thereafter, and again before leaving their employment at the University.

Supervisors are required to identify individuals who could be expected to regularly encounter excessive noise levels and to refer them, as necessary, to Health and Wellness for an audiogram.

STEP 5 Mitigation measures

Key activities

- Understand and apply reasonable, hierarchal risk mitigation measures to protect workers.
- Understand hearing protective devices.
- Ensure workers have suitable knowledge, training, and experience.
- Share examples of warning signage.

Regulation 381 requires that reasonable efforts be made to control noise propagation at its source. Elimination of noise to the extent feasible must first be explored before providing hearing protection to workers. Where elimination of noise is not feasible, further engineered controls (e.g., enclosures, mufflers, etc.) must be explored prior to providing hearing protection. If engineered control measures are not available or practical, or if additional protection is required, hearing protection can be a reasonable hazard control method.

Hearing protective devices

As clearly indicated in Regulation 381, hearing protective devices (HPDs) are considered a last resort for worker protection. This is because HPDs do not remove the hazard; rather, they protect a single worker, assuming the ear insert (plug) or other HPD is worn correctly. HPDs come in a variety of shapes, styles, and types; however, the most common are the foam roll-down type.

Figure 1 – Example of roll-down hearing protection.

These can be commonly found (individually wrapped) in areas across campus that have already been identified as “noisy”, such as at the entrance to the powerplant, entrances to workshops, etc. 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, notify your supervisor.

Note that personal audio devices, such as iPods and MP3 players, are not considered suitable hearing protection. Refer to CSA Z94.2-14 for more information and examples of hearing protection.

Training and information

Before a worker receives and wears hearing protection, a supervisor must provide them with instructions on how to properly use HPDs. The supervisor must also explain the device’s limitations and why the protective equipment is required. Information about these devices is typically available from the manufacturer or on the supplier’s website. A self-guided workshop is available online, and upon request, the Office of the Chief Risk Officer can provide sample fitting aid to help users learn how to properly insert roll-down earplugs into their ears..

Warning signage

Regulation 381 indicates that 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). Most uOttawa signage is installed where noise regularly exceeds 80 dB(A). Pre-defined signage can be requested through Facilities.

Figure 2 - Example Noise Hazard Signage.