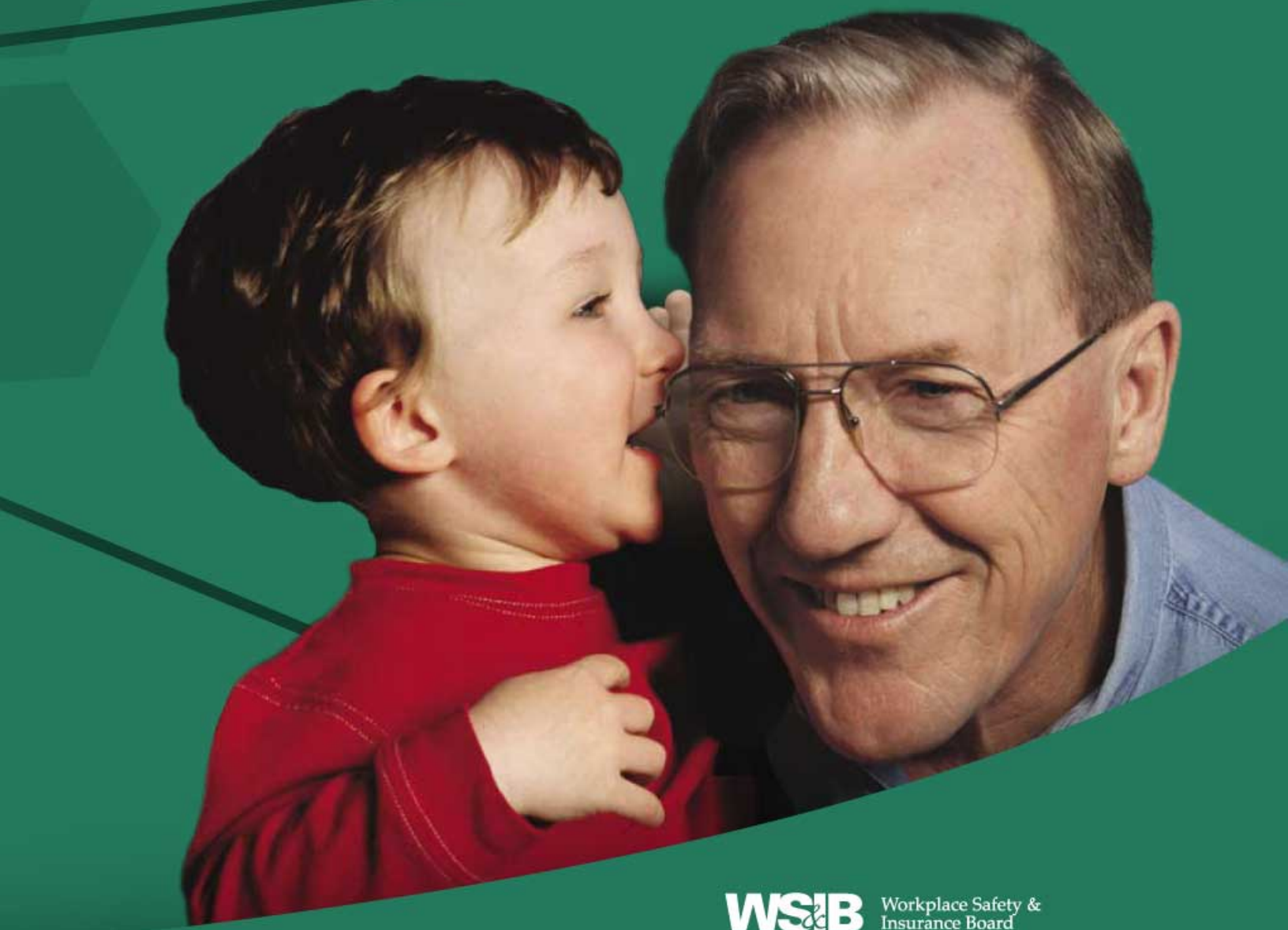
Hearing for Life

L'ouïe pour la vie

A Guide to Noise Control and Hearing Conservation (NCHC)



WSIB ONTARIO
Workplace Safety & Insurance Board

CSPAAT
Commission de la sécurité professionnelle et de l'assurance contre les accidents du travail

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Understanding Hearing Loss and Noise Hazards

This Guide is designed to assist you with strategies to recognize, assess, and control noise in order to protect the hearing of all persons in your workplace.

What is Noise and When is it a Hazard?

Noise is unwanted sound. Sound consists of pressure changes in the air created by vibration and transferred to the ear by sound waves. Sound levels are measured in decibels (dBa). In order to protect hearing, it is important to be aware of the following characteristics of noise:

- **INTENSITY:** SOUND ENERGY PER UNIT TIME
- **FREQUENCY:** NUMBER OF SOUND WAVES PER SECOND AS MEASURED IN HERTZ
- **DURATION:** HOW LONG THE NOISE LASTS
- **PERIODICITY:** HOW INTERMITTENT THE NOISE IS
- **IMPULSIVE:** A SINGLE (OR MULTIPLE) SOUND PRESSURE PEAK(S) OR A SHARP PRESSURE PEAK WITHIN A SHORT TIME INTERVAL

The higher the noise levels and the longer the exposure to noise, the more likely it will be harmful. Intense and impulsive noise close to the ear can cause immediate, traumatic, and permanent hearing loss.

There is no way to recapture lost hearing.

Once hearing loss is permanent, a person will need to adjust to having decreased hearing ability for the rest of his/her life. Noise is also capable of producing both serious physical and psychological stress.

Even relatively large hearing loss may go unnoticed in a young employee. While most hearing loss occurs in the early years of noise exposure, effects often only become apparent at older ages.

Why is Noise a Hazard?

Noise can be a threat to hearing because the ear never shuts down – it is always working, even during sleep. Occupational hearing loss takes about five years of continuous exposure to develop; however, the *higher* the noise level exposure, the *sooner* hearing loss develops.

Because hearing loss occurs slowly, many people are unaware of any hearing impairment until it is *too late*. If you need to raise your voice to talk, then the noise level is high enough to cause hearing loss.

If you need to raise your voice to talk, then the noise is high enough to cause hearing loss.

Young employees with five to ten years of noise exposure are at the highest risk of hearing loss, unless there is a good hearing protection program in the workplace, where they can learn to protect their hearing before hearing loss becomes permanent (NIOSH, 1999).

What are the Effects of Noise?

Noise can cause a number of negative health effects including:

- TEMPORARY HEARING LOSS FROM SHORT-TERM EXPOSURES TO HIGH NOISE LEVELS, WITH NORMAL HEARING RETURNING AFTER A PERIOD OF REST
- PERMANENT HEARING LOSS AFTER PROLONGED EXPOSURE TO HIGH NOISE LEVELS
- TINNITUS - A RINGING OR BUZZING IN THE EARS OR HEAD
- INCREASED BLOOD PRESSURE AND STRESS
- INABILITY TO SLEEP, FATIGUE, AND OTHER SLEEP PROBLEMS

- A SENSE OF ISOLATION AND INTERFERENCE WITH GENERAL WORKPLACE COMMUNICATIONS
- INABILITY TO HEAR WARNINGS OF IMMINENT SAFETY HAZARDS DUE TO EXCESSIVE NOISE

How Does Noise Cause Hearing Loss?

When the cilia of the inner ear are exposed to loud noise over extended periods of time, they become permanently damaged. This damage causes hearing loss; when hearing loss becomes profound it causes deafness. The images below illustrate this degenerative process:

Sensitive hairs called cilia on the spiral tube (cochlea) of the inner ear shown in an undamaged condition. Cilia vibrate when a sound is conducted to them by the eardrum and ossicles (small bones) of the middle ear. The movement of the hair cells transmits electrical impulses down the auditory nerve to the brain. That is when you 'hear' a sound.

The inner ear after damage to hearing. Note the missing cilia hairs, which never grow back.

Hearing loss can be made worse by extensive noise exposure combined with chemical, heat and/or vibration exposure. Chemicals, such as arsenic and solvents – and metals, especially those such as lead and mercury – can also increase the rate of cilia loss, and thus increase the likelihood of hearing loss (as well as harming other areas of the body, i.e. the lungs, skin, eyes, brain and liver).

Vibration and extreme heat are other contributing factors which are potentially very harmful to hearing when combined with noise exposure.

How Does a Person Experience Hearing Loss?

Hearing loss begins when one is unable to hear consonants (for example, those words that begin with the letters *b*, *c*, and *k*). The words *book*, *cook*, and *look* all sound like *oooo*, resulting in a loss of sound information and the message.

As a result, people tend to rely on lip reading or speech cues as aids to understanding. Difficulty in hearing a conversation in a crowded room is a sign that hearing loss has probably begun.

As hearing damage worsens, a person will first experience difficulty hearing children's voices, then women's voices, and finally men's voices.

If the person is employed in a workplace that is primarily male, it follows that the last sounds the person can hear are male co-worker's voices. The inability to hear male voices is usually a mark of severe hearing loss.

Managing Noise Control and Hearing Conservation

The Importance of Leadership

It is possible to manage the risks from exposure to noise and the effects of hearing loss. The process begins with leadership at your company and it starts with *you*.

Audit Tool reference pages 5-7

A company's attitude about safety guides behaviour by serving as a central point of reference for decision-making by both employees and management. Employee *characteristics* (such as knowledge about health risks), *availability of personal protective equipment*, and the *social* and *physical environment* of the workplace, also contribute to employee adherence to safety practices.

Senior *management commitment and leadership are essential* to establishing organizational noise exposure standards and targets. The **employer** is responsible for **establishing, managing,** and **monitoring** a Noise Control-Hearing Conservation (NCHC) program. Management expectations on NCHC need to be set out in the organization's health and safety policy.

management commitment and leadership are essential

Roles and Responsibilities

Responsibilities for tasks associated with NCHC need to be assigned to appropriate employees and supervisors within the organization. These may include: *senior managers; supervisors; employees,* and; *members of the Joint Health and Safety Committee* (JHSC), or; *Health and Safety Representative* (H&S Rep), or; a *dedicated NCHC team*, — which is put together for the express purpose of establishing and maintaining these responsibilities. (See Glossary.)

Assigning responsibility for NCHC needs to be consistent with the Internal Responsibility System (IRS). A major principle of the IRS is that everyone in a workplace has a *direct responsibility* for health and safety and is expected to practice it within their level of authority and scope of the job.

The NCHC team is consistent with the legislated obligations of the employer, supervisor, employee, and JHSC/H&S representative. Responsibilities of the JHSC and the H&S representative include making *recommendations* to the employer on noise control and hearing protection.

Recognizing Noise

Education

The major challenge in decreasing/eliminating the noise hazard is *educating employees* to not take noise for granted.

This is difficult because noise does not result in any visible physical changes. **In fact, noise-induced hearing loss is an invisible, but very real, occupational disease.** It rarely causes pain, is gradual in onset, and does not affect all parts of speech at the same time. Employees, lulled into believing that noise is just part of their normal workplace environment, need education about the hazard so that they can identify a potential health risk and take action. *Formal education sessions, Joint Health and Safety audits, audiogram testing* and *counseling, role modeling of hearing protectors,* and *signs* and *visual reminders of the noise hazard* all serve to remind employees to protect their hearing.

Audit Tool reference page 8-11

Employees' Concerns

Employees educated in noise safety have the tools to raise their level of awareness, so that they can ask the right questions of supervisors and co-workers — *before* they become hazards.

Supervisors need to understand that they are expected to listen and follow up promptly on action requests posed by employees.

Noise issues identified and followed up at the time of initial reporting are less likely to become health problems.

Common Measurement Tools

Tools used to identify noise as a hazard include: *noise surveys; engineering surveys; dosimetry,* and; *audiograms*. An example of hazardous noise levels in the workplace is the inability to communicate without shouting, when within an arm's length of a fellow employee.

Noise surveys measure environmental noise in A-weighted decibel levels using a sound level meter to determine if noise levels in the workplace meet exposure limits and standards. The results can be plotted on a "*noise map*" to show noise level measurements for different areas of the workplace.

Noise measurements should include all workplace areas and must be representative of typical production cycles. Noisy processes performed occasionally, or during the off-shift, should also be measured.

Engineering surveys typically use more sophisticated acoustical equipment, which provide information on the frequency/intensity composition of the noise being emitted by machinery or other sound sources in various modes of operation.

Dosimetry measures an employee's personal exposure to noise over a workshift, to obtain a time-weighted average (TWA). These measurements are used to determine the total noise exposure for an 8-hour period.

Audiograms are hearing tests that are used to monitor hearing hazards to determine if employees are damaging their hearing, whether noise control measures are effective, and if the hearing protection program is working. When hearing tests are used to monitor for noise hazards, results must be compared with a baseline (a hearing test done at the beginning of employment) to determine if hearing loss is occuring.

Assessment as a Basis for Action

Assessment compares the findings of data collected from the use of noise measurement tools, such as *surveys* or *audiograms*, to company standards. **It's very important for a company to establish exposure standards.** Workplaces are encouraged to exceed the minimum requirements for compliance, rather than merely meet the legal standards.

Audit Tool reference page 12-14

It's very important for a company to establish exposure standards.

Guidelines, such as the current ACGIH threshold limit values (TLVs), can be used to develop company exposure standards. Once the standards for noise exposure are established, the ongoing assessment of noise exposures can begin.

The assessment process allows for decision-making for control and program components. Data used for this process includes: *records of past noise exposures; aggregate data related to company trends; audiometric* and *biological measurements of the audiometer; noise survey data;* and; *noise maps*.

Data recording is an important piece of any effective NCHC program to base management decisions on relative to noise in the workplace.

Using Noise Control to Minimize Risk

Noise controls are intended to eliminate or manage hazardous exposure in order to remove or minimize the risk of hearing loss. In some cases, the application of a relatively simple noise control solution can reduce the exposure to below a hazardous level.

Audit Tool reference pages 15-18

In other cases, the noise control/reduction process may require more complex interventions accomplished in stages over a period of time. By reducing noise by even *a few decibels*, one can reduce the risk to hearing.

Use Engineering Controls to Reduce Noise

Engineering controls require *modifications to* (*or replacement* of) equipment, or, related physical changes at the *source* or *path* of the noise.

Reducing noise exposure through engineering controls is the goal. **This is a priority**! Consult an *acoustic engineer* for assistance to institute engineering controls, such as:

- reducing noise at the source by installing mufflers
- interrupting the noise path by installing acoustical enclosures and barriers
- reducing reverberation by installing sound-absorbing material
- reducing structure-borne vibration by installing vibration mounts and providing proper lubrication

Engineering controls also include specifying low noise levels when purchasing new equipment. Many types of previously noisy equipment are now available in noise-controlled versions.

In any plans for new facility construction or renovation, include plans for noise control.

Using Administrative Controls to Enforce Protection

Administrative controls are changes in the work schedule or operations that reduce *exposure* or *duration* of exposure to the hazard.

Examples include operating a noisy machine on the second or third shift when employees are not in the area, or, shifting an employee to a less noisy job once a hazardous daily limit has been reached.

Cautionary note: The practice of rotating workers between quiet and noisy jobs may reduce the risk of substantial hearing loss in a few employees, but it may actually increase the risk of small hearing losses in many employees.

Identifying locations or tasks where hearing protection is required is an administrative control. Such identification may be by signage or some visual object, such as a *flashing light*, that identifies a noisy area.

Providing a "noise map" of the workplace to highlight where hearing protection is required is a good way to define and communicate to employees the noise levels that coincide with company policy and require hearing protection.

Personal Hearing Conservation is a Minimum Protective Barrier

Personal protective equipment provides the employee with control over noise exposures, but it is the *least preferred* means of controlling noise.

Audit Tool reference page 16

Hearing protectors are recommended when noise is above recommended exposure limits. Employees must be properly fitted with hearing protection that is *suitable to the exposure, provides personal comfort,* and for which they are *trained* in its *maintenance* and *use*.

Employee Training for Noise Control and Hearing Conservation is Essential

Education and training are critical elements of a good NCHC program. They are *essential* to obtaining the sincere and energetic support of management and the *active participation of employees*.

It's essential for employees and managers to receive information about preserving their hearing as well as the dangers of noise. Education provided through *mandatory seminars* and *training sessions* is a means to provide such information. It's important to keep records on employee training.

People are more likely to protect their hearing, on and off the job, when they understand *why* it is important — and are also more likely to tell others how to protect their hearing.

Noise Control-Hearing Conservation (NCHC) Programs Help Control Noise

Establishing a *Noise Control and Hearing Conservation Program* is an excellent way of coordinating activities to control noise exposure.

Education and training are critical elements of a good NCHC program.

The program includes management practices that can be assigned to a team of employees charged with the role and responsibility of controlling exposures in the workplace. The team's responsibilities include setting standards and developing procedures to manage noise exposure and hearing conservation for all persons at the workplace.

Evaluating your Noise Control-Hearing Conservation Activities to Check Effectiveness

Evaluation techniques may include *interviews, observations, workplace inspections, audits, complaints/concerns*, and *reviews* of injury and illness records, such as WSIB claims and referrals to the JHSC or the Ministry of Labour. Standards should be assessed to ensure that they meet legislative requirements and current acceptable practices.

A thorough evaluation of all the NCHC program components is necessary to determine if the program is working and where there may be opportunities for improvement.

Monitoring test results (*dosimetry, area surveys,* and *audiograms*) and related record keeping are critical elements for evaluation. Although some biological measures such as audiograms require regularly scheduled evaluations to determine slight shifts in hearing, other measures do not.

Plans should include scheduled evaluation of procedures, such as *administration, use of personal protective equipment,* and *training*. Determine what measures are needed to measure noncompliance to company standards and ensure that the data is used to make improvements. Make positive acknowledgement of appropriate behaviour and compliance.

A relationship exists between *employee knowledge* and *attitudes* regarding hearing loss, and *employee behaviour* to prevent hearing loss. Evaluate your NCHC program by assessing employee training and behaviour.

Acknowledge Success and Make Improvements

Enhance the program by recognizing and acknowledging those who have contributed to and maintain it. Acknowledge the people who are working to continuously improve company standards and the noise control - hearing conservation program.

Use the information collected in the assessment and evaluation steps of your program to improve standards, procedures, and employee/supervisor compliance to company standards.

Next Steps to Controlling Noise

The **Program Set-up** document in the Appendix may be used to establish and apply your program. Use the **Audit Tool** to identify and address the gaps in your program, and to provide guidance in the *action plan* for an effective Noise Control and Hearing Conservation Program.

Use the Program Set-up or Audit documents to plan and apply your next steps.

Glossary of Hearing Terminology

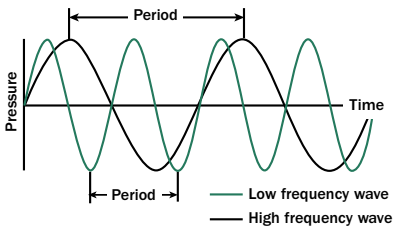
A-weighting: An electronic filter within a sound level meter or dosimeter that emphasizes or de-emphasizes certain sound frequencies in the calculation of an overall sound pressure level. This approximates how the human ear perceives low intensity noise levels, and the use of A-weighting is required for measurement of workplace noise levels.

Administrative controls: Management processes and procedures designed to limit noise exposure. This could include modifying employees' schedules or locations or modifying the operating schedule of noisy machinery.

Air conduction hearing screening: Measurement of hearing made through earphones. The entire auditory system is evaluated.

Annoyance: A common effect of noise or sound. Annoyance can be affected by the frequency, intensity, duration, periodicity, and other qualities of the sound or by personal tolerance. There is no simple method of determining annoyance.

Audiogram: A graph of hearing sensitivity. The various test frequencies are plotted on the horizontal axis from 250 Hz to 8000 Hz. The vertical axis shows the degree of hearing loss in dB.



Comparative periods of high and low frequency sound waves

Audiologist: Provides clinical services for hearing or balance disorders, using audiometers, computers, and other testing devices. They may recommend, fit, and dispense amplification systems -- such as hearing aids and alerting devices, and, independently develop and carry out treatment programs. An Audiologist typically has a masters degree in their field of expertise and is a key provider of information and counselling to those exposed to excessive noise. Audiologists also work cooperatively with other professionals, such as doctors, therapists, and teachers, to coordinate appropriate healthcare and education.

Audiometer: An instrument for measuring individual hearing acuity.

Audiometric evaluations: The results of audiometric testing conducted on employees.

Audiometric technician (Audiometrist): The person who administers the audiogram and provides advice on hearing protection and follow-up care. The audiometrist may also perform noise assessments in workplaces using sound level meters and dosimeters. Certification requires achievement of a 24-hour training program.

Average noise level (Equivalent noise level): The noise (sound) level that represents the risk of hearing loss in the workplace. The average noise level is normally measured with a dosimeter and depends on the DURATION and INTENSITY of exposure, the EXCHANGE RATE, and other criteria programmed into the dosimeter. The average noise level may be known by different names, depending on the exchange rate and criteria. It is often abbreviated as '*Lav*', depending on the exchange rate and criteria.

C-weighting: An electronic filter within a sound level meter or dosimeter that emphasizes or de-emphasizes certain sound frequencies in the calculation of an overall sound pressure level, which approximates how the human ear perceives high intensity noise levels. C-weighted noise levels may be used during selection of hearing protection.

Calibration (Biological): The audiometrist conducts a hearing test on himself/herself and a volunteer to ensure that the readings are accurate before beginning the test procedure on the employee.

Calibration (Field): Calibration performed by the user before and after use of a sound level meter or noise dosimeter.

Calibration of audiometer: A measurement by an audiometric sound (AS) technician on the audiometer to ensure that the sound levels conform to audiometric standards. A calibration device produces a known sound pressure on the microphone of a sound level measurement system to adjust the system to standard specifications.

Cochlea: ASpiral tube of the inner ear, where fluid -filled sacs convey sound vibrations to specialized cells. These cells then generate nerve impulses to the brain, which is what we 'hear'.

Continuous noise: Noise that is present for long periods, often with little variation in intensity or other qualities.

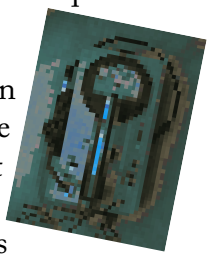
Criterion level: For programming of noise dosimeters, the maximum allowable exposure for 8 hours.

Decibel: Measurement unit used for sound, abbreviated as dB. The decibel scale is logarithmic, preventing easy addition, subtraction, or other calculations.

Decibel, A-weighted: A-weighted overall sound pressure level, abbreviated as 'dBA' or 'dB(A)'.

Decibel, C-weighted: C-weighted overall sound pressure level, abbreviated as 'dBC' or 'dB(C)'.

Dose (Noise dose): A method of expressing employee exposure to noise, using percent. A 100% dose means that the employee has been exposed to an average noise level equal to the exposure limit.



Dosimeter (Dose meter): An instrument worn by an employee for determining the full shift exposure to noise and the average sound level. The dosimeter is programmed before use with an *exchange rate* and other criteria.

Dosimetry: The use of dosimeters to evaluate employee exposure to noise.

Doubling rate: See Exchange rate.

Duration: The length of time one is exposed to the noise.

Engineering controls: Measures taken to either ensure that machinery doesn't produce noise that damages hearing, or absorbs or reflects the noise before it reaches employees.

Equivalent noise level: See Average noise level

Exchange rate: A factor used in the calculation of *average sound levels, programming of dosimeters,* or the *addition* and *subtraction* of *sound levels*. this factoring of shifting logrithmic sound waves allows measurements to be more easily understood. Exchange rate is often specified or implied in exposure standards. The common exchange rates are 3 dB and 5 dB, but others are used as well.

Frequency: The number of times the sine wave of sound repeats itself, expressed in Hertz (Hz). The frequency range for human hearing lies between 20 Hz and approximately 20,000 Hz. The sensitivity of the human ear drops off sharply below 500 Hz and above 4,000 Hz.

Hearing level: A measured threshold of hearing at a specified frequency, expressed in *decibels* relative to a specified standards for normal hearing. The deviation of an individual's threshold is measured in *decibels* from the zero reference on the *audiometer.*

Hearing loss: Impairment of auditory acuity. Hearing impairment is measured in decibels as a set of threshold levels at specified frequencies.

Hearing loss (Bilateral): Since sound is symmetric, loss of hearing occurs in both ears.

Hearing loss (Conductive): A negative change in hearing due to reduction of sound transmission through the outer ear, middle ear, or both.

Hearing loss (Sensorineural): A change in hearing due to damage to the structures in the cochlea to the 8th cranial nerve.

Hearing loss (Mixed): Conductive and sensorineural hearing loss occurring simultaneously.

Hearing loss (Permanent): The inability to hear sound. No recovery of the inner ear cells is possible since the damage is permanent.

Hearing loss measurements:

0 - 20 dB normal limits
21 - 40 dB mild hearing loss
41 - 55 dB moderate hearing loss
56 - 70 dB moderately severe hearing loss
71 - 90 dB severe hearing loss
>91 dB profound hearing loss

Hearing protective devices: Earmuffs, plugs or circumaural (around the ear) devices that reduce the noise level impacting the eardrum. Plugs are inserted into the external ear canal, earmuffs are applied over the external ears, and circumaural devices cover the entrance to the external ear canal.

Hertz (Hz): Unit of measurement of frequency, equal to cycles per second.

Hold: A feature on many sound level meters that permits measurement of peak or maximum noise levels by keeping the meter display at the highest reported value.

Impact: An "impulse sound" resulting from the collision of two objects (e.g. hammer striking an anvil or a stamping press).

Impulse: A sound of short duration and high intensity (e.g. release of steam from a valve or an explosion). Impulse and impact sound should be considered during measurement and control of noise, and present a different risk to hearing than continuous noise.

Intensity: The sound energy flow through a unit area in a unit time.

Intermittent noise: Noise with noticeable changes over time, in either intensity or other qualities (e.g. maintenance shop).

L: Common abbreviation for noise level, with units of dBA.

Linear: Measurement of overall or octave band sound levels without use of a weighting filter. Linear measurements are required for octave band analysis or peak noise levels.

Loudness: The judgment of sound intensity, which depends upon the sound pressure and frequency of the stimulus.

Noise: *Unwanted sound*. Any sound not occurring in the natural environment, such as sounds emanating from machinery, highway traffic, and industrial, commercial, and residential sources. Also includes an erratic, intermittent, or statistically random oscillation.

Noise (Hazardous): Any sound for which any combination of frequency, intensity, or duration is capable of causing permanent hearing loss in a specific population.

Noise Control-Hearing Conservation Program: *Administrative controls, engineering controls, audiometric surveillance, training,* and *hearing protection* are the four components of preventing noise-induced hearing loss.

Noise Control-Hearing Conservation Team: Your team may consist of one person or several people, depending on the size of your company. It can include *management, JHSC members, a nurse, audio technician, supervisors,* and others.

Noise-induced hearing loss: Hearing loss that begins at the higher frequencies (3,000 - 6,000 Hz). It begins as a temporary threshold shift in the pattern of hearing. The shift raises the level of loudness required to hear sounds and may include a ringing or buzzing in the ears (tinnitus) and mild hearing loss at the higher frequencies. Often abbreviated as 'NIHL'.

Noise level (Sound level): The measured intensity of sound/noise at a location. It is often abbreviated as 'L".

Noise level (Maximum): The highest overall noise level measured using a dosimeter or a sound level meter with a weighting filter. It is different from *peak noise level* because of the effect of the weighting filter and response rate.

Noise level (Overall): Sound level meters and dosimeters measure all frequencies and report a single, combined result. The selected weighting filter affects the overall noise level.

Noise level (Peak): The peak overall noise level caused by an instantaneous impact or impulse noise. Measurement of peak noise levels requires use of Fast response and linear weighting. Peak noise levels are measured using a dosimeter or a sound level meter with a Hold feature.

Noise map: A diagram of the workplace that identifies the noise levels expected in different areas of the workspace.

Octave band: A concept borrowed from music that is useful in design of *engineering controls* and selection of hearing protection. Commonly identified by the centre frequency.

Octave band analyzer: A device that may be attached to a sound level meter that allows measurement of sound levels in different octave bands. The results may be used in selection of engineering controls or hearing protection.

Ototoxicity: Chemical-induced hearing loss. Some chemicals can cause hearing loss without noise exposure. However, most ototoxicity occurs as a result of combined exposure to high levels of noise and solvents, some metals, or other chemicals that may speed up the hearing loss process.

Periodicity: The length of time between sounds.

Pitch: The subjective judgment of the frequency of sound by humans.

Pure tone: Sound at a single frequency. Pure tones are used in audiometry. Pure tone noise may be produced in workplaces because of fans and flowing or escaping gas or liquid. Pure tone sound presents a different risk of *annoyance* or hearing damage.

Response rate: A characteristic of a sound level meter or dosimeter that determines how rapidly it responds to changing noise levels. Two response rates are normally available: Slow and Fast. Response rates were originally used in sound level meters to permit reading of a needle meter display.

Response rate (Fast): The response rate commonly used for measurement of peak noise levels in a workplace. Meter results with Fast response are often difficult to read unless a Hold feature is used.

Response rate (Slow): The response rate commonly used or required for measurement of workplace noise. Meter results with Slow response are considered to be short-term (1 second) averages, and are relatively easy to read even with fluctuating noise levels.

Sound: An oscillation in pressure, stress, particle displacement, particle velocity in an elastic or partially elastic medium, or the superposition of such propagated alterations.

Sound level meter: An instrument consisting of a *microphone, amplifier, output meter,* and *frequency weighting networks* that is used for the measurement of noise and sound levels. Often abbreviated as Slm.

Sound survey: The measurement of sound levels in an environment using a *sound level meter*.

Temporary hearing loss: The inability to hear certain sounds following an exposure to loud noise. After a recovery phase, hearing returns.

Threshold: A guideline applied to a set of conditions. Conditions may include *audibility, sound pressure, exposure to certain chemicals,* and *length of time exposed* to sound pressure and chemicals.

Threshold shift: A change in the threshold of audibility at a specified frequency from a previously established threshold. The amount of threshold shift is usually expressed in decibels.

Threshold shift (Permanent): After prolonged and repeated exposure to noise, a permanent hearing loss may occur. Often abbreviated as 'PTS'.

Threshold shift (Temporary): A temporary impairment of hearing acuity indicated by a change in the audibility threshold. Often abbreviated as 'TTS'.

Time-weighted average (TWA): A-weighted average sound level measured with a 5-dB exchange rate and SLOW meter response, normalized to 8 hours. (NOTE: This is a simplification of the definition used in US regulations.)

Tinnitus: Ringing in the ear or noise sensed in the head, possibly due to an acoustic trauma or long-term noise exposure, and which persists in the absence of acoustical stimulation (may indicate a lesion of the auditory system).

Noise induced Hearing Loss(NIHL) Related References

Guidelines and Standards

The following resources are provided to assist in finding more information about NIHL. Please also see the links on our Web site at: www.wsib.on.ca

American National Standards Institute
www.ansi.org

Canadian Acoustical Association
www.canadianenvironmental.com

Canadian Centre for Occupational Health and Safety (2000). Noise Control in Industry: A Basic Guide, Hamilton, Ontario

Canadian Centre for Occupational Health and Safety. Legislation about the Canadian Standards Association
www.ccohs.ca/legislation

Canadian Environmental Auditing Association
www.ceaa-acve.ca

Canadian Registration Board of Occupational Hygienists
www.crboh.ca

Canadian Standards Association, CAN/CSA Standard Z107.9-00
www.csa-intl.org/online

Council for Accreditation in Occupational Hearing Conservation Manual (1985). Association Management Corporation, Springfield, NJ, 07081

NIOSH (National Institute for Occupational Safety and Health)
www.cdc.gov/niosh

Noise Regulation Alberta Regulation 314/81
www.canlii.org/ab/regu/ra/

Standards Council of Canada
www.scc.ca

Sound Advice, WCB of BC Noise Measurement
www.safetyandsecurity.bcit.ca

The Natural Resources Conservation Authority, A Review of Jamaican and International Noise Standards
www.nrca.org/standards/noise/review_noise_standards.htm

Partners in Hearing Protection

WSIB Noise Induced Hearing Loss Manager
Phone: 1-800-663-6639

Health And Safety Associations (HSAs)

Construction Safety Association of Ontario
Phone: 416-674-2726
1-800-781-2726
Fax: 416-674-8866
www.csao.org

Education Safety Association of Ontario
Phone: 416-250-8005
1-877-732-3726
Fax: 416-250-9190
www.esao.on.ca

Electrical & Utilities Safety Association
Phone: 416-640-0100
1-800-263-5024
Fax: 416-640-0117
www.eusa.on.ca

Farm Safety Association
Phone: 519-823-5600
1-800-361-8855
Fax: 519-823-8880
www.farmsafety.ca

Health Care Health and Safety Association
Phone: 416-250-7444
1-877-250-7444
Fax: 416-250-9190
www.hchsa.on.ca

Industrial Accident Prevention Association
Phone: 416-506-8888
1-800-406-4272
Fax: 416-506-8880
www.iapa.on.ca

Mines and Aggregates Safety and Health Association
Phone: 705-474-7233
Fax: 705-472-5800
www.masha.on.ca

Municipal Health and Safety Association
Phone: 416-246-6472
Fax: 416-246-0872
www.mhsao.com

Ministry of Labour
Phone: 416-326-7770
1-800-268-8013
Fax: 416-326-7761
www.gov.on.ca

Ontario Forestry Safe Workplace Association
Phone: 705-474-7233
Fax: 705-474-4530
www.ofswa.on.ca

Ontario Service Safety Alliance
Phone: 416-250-9111
1-888-478-6772
Fax: 416-250-9500
www.ossa.com

Pulp & Paper Health and Safety Association
Phone: 705-474-7233
Fax: 705-472-8250
www.pphsa.on.ca

Transportation Health and Safety Association of Ontario
Phone: 416-242-4771
1-800-263-5016
Fax: 416-242-4714
www.thsao.on.ca

Workers Health and Safety Centre provides general health and safety training as well as programs and training modules specific to your industry.
Phone: 416-441-1939
1-888-869-7950
Fax: 416-441-2277
www.whsc.on.ca

The Occupational Health Clinics for Ontario Workers (OHCOW) provide information and diagnostic services about occupational diseases such as repetitive strain injuries, noise-induced hearing loss, respiratory problems, and cancer.
Phone: 416-443-7669
1-877-817-0336
Fax: 416-443-6323
www.ohcow.on.ca

Hamilton Clinic:
Phone: 905-549-2552
1-800-263-2129

Toronto Clinic:
Phone: 416-449-0009
1-888-596-3800
Fax: 416-449-7772

Windsor Clinic:
Phone: 519-973-4800
1-800-565-3185
Fax: 519-973-1906

Sarnia Clinic:
Phone: 519-337-4627
Fax: 519-337-9442

Sudbury Clinic:
Phone: 705-523-2330
1-800-461-7120
Fax: 705-523-2606

Other Resources

The Canadian Hearing Society
Toronto, Ontario
Phone: 416-964-9595
Fax: 416-928-2523
Email: info@chs.ca
www.chs.ca

The National Information Center on Deafness
Phone: 202-651-5051
Fax: 202-651-5054

Canadian Hearing Instrument Practitioners Society
www.hearcanada.com

Canadian Association of Speech Pathologists and Audiologists
Ottawa, Ontario
Phone: 613-567-9968
1-800-259-8519
Fax: 613-567-2859
www.caslpa.ca

Canadian Hard of Hearing Association

Ottawa, Ontario
Phone: 1-800-263-8068
www.hearingcenteronline.com/services.shtml

Otolaryngology Resources on the Internet
www.bcm.tmc.edu/oto/others.html

The Canadian Hearing Society Toronto, Ontario
www.sath.org/pages/hearing or
www.bfree.on.ca

Deaf Canadian Association
Phone: 709-364-1234
www.nsd.nf.ca/other.html

Ontario Ministry of Health and Long Term Care - Healthlinks
Phone: 416-326-1234
1-800-267-8097
www.health.gov.on.ca/

Canadian International Hearing Services
Toronto, Ontario
Phone: 416-743-9756
Fax: 416-743-1232
www3.sympatico.ca/cihs

Canadian Academy of Audiology
Phone: 416-494-6672
1-800-264-5106
Fax: 416-495-8723
www.canadianaudiology.ca

OSH Answers: Hearing Protectors
Phone: 905-572-4400
1-800-263-8466
Fax: 905-572-4500
www.ccohs.ca/oshanswers/prevention/ppe/ear_prot.html

Hearing and Deafness Guidelines
www.mdm.ca/cpgsnew/cpgs/search

Virtual Tour of the Ear: Speech Language Pathologists and Audiologists
www.augie.edu/perry/ear/audiology.htm

Noise and Hearing Loss Prevention: Related Links/NIOSH
www.cdc.gov/niosh/topics/noise/pubs/pubs.html

Noise - Basic Information
www.ccohs.ca/oshanswers/phys_agents/noise_basic.html

Noise - Auditory Effects
www.ccohs.ca/oshanswers/phys_agents/noise_auditory.html

Noise - Measurement of Workplace Noise
www.ccohs.ca/oshanswers/phys_agents/noise_measurement.html

Noise - Non-Auditory Effects
www.ccohs.ca/oshanswers/phys_agents/non_auditory.html

Noise - Occupational Exposure Limits for Extended Workshifts
www.ccohs.ca/oshanswers/phys_agents/exposure_ext.html

Noise - Occupational Exposure Limits in Canada
www.ccohs.ca/oshanswers/phys_agents/exposure_can.html

Appendix: Setting Up Your Noise Control and Hearing Conservation Program

Use the checklists in this Appendix, together with the Guide to Noise Control and Hearing Conservation, to assist you in establishing your Noise Control and Hearing Conservation (NCHC) program.

Your program can be as sophisticated or as straightforward as required for your workplace, but it should include the components and educational content available in the Guide.

When you feel that your NCHC program is implemented and ready for an audit, use the Program Audit Tool to check for any gaps that can be easily corrected for an efficient and effective program in your workplace.

LEADERSHIP

Everyone is responsible to ensure a safe, noise-free workplace. The following leadership activities are designed to meet this goal.

Leadership Checklist For A Noise Control and Hearing Conservation Program (NCHC)

	Check Boxes that Apply to YOUR Workplace
Establish and ensure compliance with regulations and company noise exposure standards.	⬡
Ensure that accountabilities and responsibilities are in place for personnel responsible for noise exposure control (*managers, supervisors, JHSC, safety representatives, etc.*).	⬡
Organize education, motivation, and review sessions to maintain the NCHC program.	⬡
Supervise to ensure that the NCHC program is established and implemented.	⬡

Checklist for Company Management

Establish policies and procedures for noise control and hearing conservation.	⬡
Ensure that personnel responsible for noise exposure control are held accountable for their role in implementing the NCHC program	⬡
Encourage the participation of employees and supervisors in reinforcing the use of hearing protection devices.	⬡
Management wears hearing protection in designated noisy areas and supports the principles of the hearing conservation program.	⬡
Ensure that noise is considered as a hazard in *Fail Safe*, *HazOp*, or other risk assessments when creating job procedures, purchasing equipment, or developing new facilities.	⬡

Checklist for an Employee

Observe rules and regulations set out in the company policy and procedure manual regarding the hearing conservation program.	
Complete annual audiometric evaluation and acknowledge an understanding of the results.	
Advise of changes in hearing to management or supervisor for prompt or urgent attention.	
Ensure proper use of hearing protection at work, at home, and in the community when in noisy environments.	
Participate in hearing conservation programs provided by the company.	
Report opportunities for noise reduction in the workplace and concerns to supervisor.	

RECOGNIZING NOISE

There are many ways to recognize the hazards of noise. It can range from listening and identifying employee concerns to technical sound level surveys and audiometric evaluation. Employee and supervisor knowledge is an excellent way to identify noise and control exposure to it. Reinforced training leads to an understanding of the serious hazards of noise and better hearing conservation.

Noise Hazard Education

- Team members understand hearing conservation and the goals and policies of the hearing conservation program.
- Each team member receives training on how to carry out his/her function, especially concerning fitting and use of hearing protective devices.
- Employees attend updated education programs, including information on hearing loss and tinnitus, which focus on hearing protection on and off the job. Reinforce learning annually.
- Management acts as a role model by wearing hearing protective devices, enforcing company hearing policy requirements, and participating in educational programs.
- Evaluate all staff on their hearing conservation participation during annual company personnel reviews.

Understanding the Health Effects

- Employees understand the long-term health effects of hearing loss, dizziness, fatigue, headaches, and disturbed balance.
- Employees understand when the inability to hear warnings, or to communicate with others, is due to noise.

Complying with Laws and Company Standards

- Management understands the general provisions of the Occupational Health and Safety Act and its regulations, and the noise-related sections of the Industrial Regulations regarding noise.
- Employees understand the importance of workplace inspections and surveys/questionnaires.

Employees understand company standards and expectations for the NCHC program.	⬡
Supervisors have knowledge of noise measuring equipment and its use in the workplace.	⬡

Control Measures and Programs

Supervisors and employees understand ways to control noise hazards at the source, along the path to the employee, and at the employee, such as enclosure, use of sound absorption material, and inadequacies of hearing protection devices (earplugs and muffs).	⬡
Understand the need for management, with the support of the JHSC, to educate and train all parties.	⬡
Identify high-risk jobs (e.g., where jobs have a combined exposure to noise and/or solvents, heat, vibration, or gaseous metals).	⬡
Annual training program includes knowledge of the effects of noise on hearing, purpose of hearing protectors, advantages, disadvantages, attenuation, instruction on selection, fit, use, and care, and the purpose and procedures of audiometric testing.	⬡

Employee Concerns

Employees have to shout to hear one another at the job site.	⬡
Employees report concerns of discomfort due to noise exposure.	⬡
Employees report headaches, or consistent dull roar or ringing in their ears, after a workshift.	⬡
Employees are aware of the impact of hearing loss and the characteristics of hearing loss over time (age and exposure).	⬡
Employees are aware of how the effects of noise on their hearing are recorded on an audiogram.	⬡

Sound Level Surveys

Conduct thorough workplace noise measurements in all areas – both noisy and quiet.	⬡
Keep reports of noise survey findings available for review and future reference.	⬡
Field calibration should be performed before *and* after every day's testing.	⬡
Calibrate sound level meters and dosimeters by factory/service centre on a yearly basis.	⬡
Posting of noise warning signs and map (where applicable) of the entire workplace, to show noise readings by location and areas where hearing protection devices are required.	⬡
Use colour or shading or hash marks to alert attention to noise hazard areas. For example: • red – hearing protection is required – crossed hash-marks – (e.g., above 85 dBA) • yellow – hearing protection is recommended – vertical hash-marks – (e.g., 70 – 85 dBA) • green – hearing protection is not necessary – no hash-marks – (e.g., below 70 dBA)	⬡

Audiometric Evaluation

Audiometers are kept in good condition and calibrated professionally.	⬡
Audio booth or testing environment is calibrated annually, or if booth is moved.	⬡
Conduct weekly audiograms on people who agree to act as controls, and a daily self-administered audiogram by the person administering employee audiograms, to ensure that the audiometer calibrations are within specifications (known as biological calibration).	⬡
Conduct pre-placement/baseline audiograms on all new employees, and post-employment audiograms on all employees leaving the company.	⬡
Conduct monitoring audiograms to compare to baseline annually.	⬡
All audiogram results are reviewed by a medical practitioner who is skilled in the knowledge of hearing problems so that abnormal results are followed up with the appropriate treating physician.	⬡

Certified audiometric professionals conduct the audiograms to ensure consistent testing methods.	⬡
The audiogram includes testing at 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz bilaterally, starting with the better hearing ear.	⬡
The audiometric professional looks for significant shifts in hearing at any frequency, completes actual hearing loss calculations to identify significant threshold shifts (STS), and arranges for referral to medical follow-up as required. The audiometric professional also provides the employee with immediate feedback on possible causes from on- or off-the-job exposures. Results are kept on the employee's permanent record.	⬡
Employees who have significant threshold shifts are identified and receive follow-up action to halt hearing loss. A subsequent audiogram will confirm or deny success.	⬡
Each employee is individually fitted with hearing protection devices and trained in their proper use and care.	⬡
Monitoring audiograms are provided to employees with time-weighted averages (TWAs) of 85-99 dBA.	⬡
Employees with TWAs of >100 dBA are given repeat audiograms every six months for the first two years of exposure.	⬡
Employee auditory history information is obtained and updated annually.	⬡
Hearing protection device fitting, issuing, replacement, and user training documentation is kept for all employees.	⬡

ASSESSING NOISE

Because noise hazard varies from workplace to workplace, it needs to be assessed individually against predetermined company standards. A significant noise hazard has high potential to affect employees and can lead to severe health consequences.

Components of a Noise Hazard Assessment

Company standards are established for significant threshold shifts.	
Company expectations are established for NCHC program and accountabilities.	
Findings from sound level surveys and audiometric evaluations are assessed and measured against company standards.	
Monitor all continuous, intermittent, and impulsive sound levels.	
Conduct noise monitoring when information indicates that employees' exposure may equal or exceed company pre-established standards, such as 85 dBA TWA, using a 3-decibel exchange rate.	
Encourage employees to observe and participate in monitoring activities.	
Use representative personal monitoring (dosimetry) for highly mobile employees, areas with significantly varying sound levels, and impulse noise exposures that are at or above company standards.	

Record Keeping and Data Control

Documents/records are clear, concise, dated, and complete.	⬡
Keep records indefinitely and have them available for immediate and future reference. Examples of such records include: • Audiogram results and histories • Types of hearing protection used with Noise Reduction Ratings listed • Audiometer calibration records • Sound level meter surveys • Dosimetry calibration records and dosimeter readings • Hearing booth validation records • Sound surveys/maps • Management report for aggregate results	⬡
Noise control measures have been implemented including: • New noise equipment specifications • Educational seminars – content and date conducted	⬡
Relevant documents relating to NCHC are kept confidential and: • Employees are educated about the noise exposures specific to their areas • Exposure records of the noise survey results by the Safety Department or Hearing Conservation Program Manager are kept, where available • An employee's audiometric records are maintained	⬡

CONTROLLING NOISE

The purpose of noise control is to eliminate or manage hazardous exposures in order to eliminate or minimize the risk of hearing loss.

Reducing noise exposures at the source is the priority. Use engineering solutions or barriers where possible. Personal protective equipment is the control of last resort.

Controls on Exposure to Noise Hazards

Conduct an engineering control survey and report on findings.	⬡
Identify sources of dominant noise and contributing noise production.	⬡
Provide documentation to confirm that a noise control maintenance program exists.	⬡
Ensure that noise criteria are included in all equipment purchases.	⬡
Employee training includes sound survey results and noise recognition techniques.	⬡
Isolate or reduce noise at the source/path and at the employee when possible.	⬡
When not possible to reduce noise exposure, consider job rotations or employee rotation as a measure to reduce exposure.	⬡
Document implemented solutions and scheduled reviews to noise problems.	⬡
Include noise control in the planning of new buildings.	⬡

Hearing Protection

Be realistic and choose hearing protection devices based on comfort, practicality, ease of use and that are most suitable for the work environment.	
Fit employees individually and provide instruction on how to care for and use hearing protection devices.	
Allow employees to choose a comfortable hearing protector by providing a minimum of three sets of earplugs as per company standards (with multiple sizes). Preference is to provide two models of earmuffs and/or three sets of earplugs.	
Encourage employees to use hearing protection at home when operating noisy tools.	
Insist that all visitors follow company rules or policy regarding use of hearing protection.	
Provide a two to three week breaking-in period for hearing protection devices to "see what works best."	

PROGRAM EVALUATION

ANNUAL AUDIT

The purpose of the annual audit is to benchmark your successes, identify areas of improvement, and incorporate hearing conservation into the company health and safety strategic plan. It also assists frontline staff to maintain their watchfulness in the identification and reduction of noise in the workplace.

By making noise reduction a top priority through the annual audit process, employees and supervisors renew their commitment to work together to reduce the noise hazard. No one should have to suffer from hearing loss because of their workplace.

The annual audit and action plan should be kept as a permanent record and available to all employees for their review during the year and as a benchmark for the next year's audit.

Evaluation of the NCHC program is necessary to determine if the program is working and identify where there may be opportunities for improvement. Company standards for exposure to noise and their controls should be reviewed regularly for maintenance and continuous improvements.

Program Review Questions

Designate a key individual with authority to oversee all phases of the NCHC program.	⬡
Involve the Joint Health and Safety Committee in the NCHC program.	⬡
Management and employees maintain active communication.	⬡
Management holds personnel accountable for ensuring that noise exposures are controlled.	⬡
Use the analysis of audiometric data to provide a base for noise reduction initiatives.	⬡
Monitor the hearing conservation program annually to determine progress towards a goal of 0-5% significant threshold shift in the targeted population.	⬡