

Hearing loss prevention program (HLPP) management

Legal Notice for Standards

Canadian Standards Association (operating as “CSA Group”) develops standards through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard. Although CSA Group administers the process and establishes rules to promote fairness in achieving consensus, it does not independently test, evaluate, or verify the content of standards.

Disclaimer and exclusion of liability

This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document’s fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party’s intellectual property rights. CSA Group does not warrant the accuracy, completeness, or currency of any of the information published in this document. CSA Group makes no representations or warranties regarding this document’s compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL CSA GROUP, ITS VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWSOEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF CSA GROUP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, CSA Group is not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and CSA Group accepts no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

CSA Group is a private not-for-profit company that publishes voluntary standards and related documents. CSA Group has no power, nor does it undertake, to enforce compliance with the contents of the standards or other documents it publishes.

Intellectual property rights and ownership

As between CSA Group and the users of this document (whether it be in printed or electronic form), CSA Group is the owner, or the authorized licensee, of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. Without limitation, the unauthorized use, modification, copying, or disclosure of this document may violate laws that protect CSA Group’s and/or others’ intellectual property and may give rise to a right in CSA Group and/or others to seek legal redress for such use, modification, copying, or disclosure. To the extent permitted by licence or by law, CSA Group reserves all intellectual property rights in this document.

Patent rights

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. CSA Group shall not be held responsible for identifying any or all such patent rights. Users of this standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.

Authorized use of this document

This document is being provided by CSA Group for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:

- load this document onto a computer for the sole purpose of reviewing it;
- search and browse this document; and
- print this document if it is in PDF format.

Limited copies of this document in print or paper form may be distributed only to persons who are authorized by CSA Group to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to

- alter this document in any way or remove this Legal Notice from the attached standard;
- sell this document without authorization from CSA Group; or
- make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents hereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.



Standards Update Service

Z1007-16

February 2016

Title: *Hearing loss prevention program (HLPP) management*

To register for e-mail notification about any updates to this publication

- go to shop.csa.ca
- click on **CSA Update Service**

The **List ID** that you will need to register for updates to this publication is **2423263**.

If you require assistance, please e-mail techsupport@csagroup.org or call 416-747-2233.

Visit CSA Group's policy on privacy at www.csagroup.org/legal to find out how we protect your personal information.

Z1007-16
***Hearing loss prevention program
(HLPP) management***



™A trade-mark of the Canadian Standards Association, operating as "CSA Group"

*Published in February 2016 by CSA Group
A not-for-profit private sector organization
178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3*

*To purchase standards and related publications, visit our Online Store at shop.csa.ca
or call toll-free 1-800-463-6727 or 416-747-4044.*

ISBN 978-1-77139-681-3

*© 2016 CSA Group
All rights reserved. No part of this publication may be reproduced in any form whatsoever
without the prior permission of the publisher.*

Contents

Technical Committee on Occupational Hearing Conservation	5
Subcommittee on Hearing Conservation Management	8
Preface	10
0 Introduction	12
0.1 General	12
0.2 Elements of a hearing loss prevention program (HLPP) (see Figure 1)	12
0.3 Content of this Standard	13
0.4 Legislative context	14
0.5 Sources of occupational hearing loss	14
0.6 Non-occupational exposures	15
0.7 Effects of workplace noise and hearing loss prevention	15
1 Scope	16
1.1 General	16
1.2 Subjects addressed	16
1.3 Subjects not addressed	16
1.4 Relation to other Standards	16
1.5 Applicability	17
1.6 Users' responsibility	17
1.7 Terminology	17
2 Reference publications	18
3 Definitions	20
4 Persons involved in the hearing loss prevention program (HLPP)	24
4.1 Requirement for a hearing loss prevention program	24
4.2 Responsibilities	24
4.3 Organization's/management's role	25
4.4 Hearing loss prevention program administrator	25
4.5 Occupational health and safety committees and worker representatives	25
4.6 Role of workers	25
4.7 Roles of contractors and temporary/transient worker agencies	25
4.8 Other participants	26
4.8.1 General	26
4.8.2 Hearing loss prevention program external service providers	26
4.9 Organization's responsibility	26
4.10 Workers' responsibility	26
4.11 Contractors' and temporary/transient worker agencies' responsibilities	26
4.12 Hearing loss prevention program administrator responsibilities	26
4.13 Management of service providers	27
4.14 Audiometric technician	27
5 Detecting hazards and assessing risk	28

5.1	Overview and theory	28
5.2	Noise source identification	29
5.3	Noise level survey	29
5.4	Noise exposure measurement	30
5.5	Risk assessment	30
5.6	Ototoxicity	30
5.7	Whole-body and hand-arm vibration exposure and hearing loss	30
5.8	Influences in combination	31
5.9	Noise exposure versus noise level	31
5.10	Calculation of $L_{EX,8}$	31
5.11	Adjustments for length of work shifts	31
6	Controlling noise exposure	33
6.1	General	33
6.2	Engineering controls — Reducing the noise hazard at its source	33
6.2.1	General	33
6.2.2	Design goal	34
6.2.3	Specifying quiet equipment	35
6.2.4	Building quiet facilities	36
6.3	Administrative controls	38
7	Hearing protection devices (HPDs)	39
7.1	Overview	39
7.2	Hearing protection strategy	39
7.3	Factors to be considered in the selection of hearing protection devices	39
7.3.1	Factors to be considered	39
7.3.2	Communication and detection of warning sounds	40
7.3.3	Considering comfort for work environment and activities	40
7.3.4	General hearing protection	40
7.3.5	Specialized hearing protection	44
7.4	Use and fitting of HPDs	47
7.4.1	General	47
7.4.2	Use and fitting of earplugs	47
7.4.3	Insertion of foam earplugs	48
7.4.4	Insertion of push-to-fit earplugs	48
7.4.5	Insertion of premoulded earplugs	48
7.4.6	Insertion of formable earplugs	49
7.4.7	Insertion and removal of custom-moulded earplugs	49
7.4.8	Insertion of semi-insert earplugs	50
7.4.9	Use and fitting of earmuffs	50
7.4.10	Use and fitting of helmets	51
7.4.11	Field attenuation estimation systems (FAES) — Fit testing systems	51
7.5	Overprotection	52
7.6	Effect of temporary removal of an HPD while exposed to noise	52
7.7	Communication in noise	53
7.7.1	General	53
7.7.2	Interpersonal communication	53
7.7.3	Radio communication	53
7.8	Cleaning and maintenance of hearing protection devices (passive and specialized devices)	54

7.8.1	General	54
7.8.2	Cleaning and maintenance of earplugs	54
7.8.3	Cleaning and maintenance of earmuffs	54
7.9	Provision of hearing protection	55
7.9.1	General	55
7.9.2	Selection of hearing protection devices	55
7.9.3	Use of hearing protection devices	55
7.10	Using attenuation data and derating to select HPDs	55
7.10.1	General	55
7.10.2	Attenuation	56
7.10.3	Laboratory versus field attenuation	56
7.10.4	Attenuation measurement methods	56
7.10.5	Derating hearing protection	56
7.11	Assigning hearing protection devices based on attenuation and noise exposure levels	58
7.12	Methods for selection of hearing protection devices	58
7.12.1	General	58
7.12.2	Class	58
7.12.3	Single number ratings: NRR and SNR(SF ₈₄)	59
7.12.4	Octave-band computation	60
7.13	Double protection	60
8	Audiometric testing (hearing tests)	61
8.1	Audiometric testing programs	61
8.1.1	General	61
8.1.2	Types of audiometric tests	62
8.2	Provision of audiometric tests	62
8.2.1	General	62
8.2.2	Reference audiometric test	62
8.2.3	Monitoring (surveillance) audiograms	63
8.2.4	Exit audiogram	63
8.3	Audiometric technician	63
8.4	Use of the audiometric test results	64
9	Hazard communication	65
9.1	Warning signs	65
9.2	Notification to workers	66
10	Education and training	66
10.1	General	66
10.2	Worker education	67
10.3	Worker training	68
10.4	Maintenance of a culture of hearing loss prevention	69
10.5	Workers with hearing loss	69
11	Monitoring the HLPP's performance	69
11.1	General	69
11.2	Visual inspection	70
11.3	Discussion with workers and supervisors	70
11.4	Periodic noise level and noise exposure measurements	70

11.5	Outcome measures	71
11.5.1	General	71
11.5.2	Worker questionnaires	71
11.5.3	Spot checks	71
11.5.4	Worker participation	71
11.5.5	Audiometric test results	71
11.6	Record-keeping	72
11.7	Continuous improvement	72

12 Special challenges 73

12.1	General	73
12.2	Workplace challenges	73
12.2.1	Communication in noise	73
12.2.2	Workplaces where noise exposure is difficult to measure	73
12.2.3	Workplaces with difficult-to-control noise	73
12.3	Worker challenges	75
12.3.1	Transient or seasonal workforce	75
12.3.2	Challenges due to pre-existing hearing loss	76

Annex A (informative)	— Ototoxicity	78
Annex B (informative)	— Engineering controls	80
Annex C (informative)	— Best practices in hearing loss prevention	83
Annex D (informative)	— Sample sound level map	87
Annex E (informative)	— Risk assessment	89
Annex F (informative)	— Canadian legislative context	92
Annex G (informative)	— Unprotected exposures	96
Annex H (informative)	— Comparison of and guidance for applying methods of estimating protected exposure	97
Annex I (informative)	— Brief summary of “Plan-Do-Check-Act” management theory	99
Annex J (Informative)	— Periodic assessment of HLPP performance	101
Annex K (informative)	— Explanation of dBA and dBC	104
Annex L (informative)	— Safety concerns for those workers with hearing loss	105
Annex M (informative)	— Hearing protection job compatibility analysis	107

Technical Committee on Occupational Hearing Conservation

T. Kelsall	Hatch, Mississauga, Ontario <i>Category: General Interest</i>	<i>Chair</i>
A. Behar	Ryerson University, Scarborough, Ontario <i>Category: User Management</i>	<i>Vice-Chair</i>
E.H. Berger	3M Personal Safety Division, Indianapolis, Indiana, USA <i>Category: Producer Interest</i>	
I.B. Bhunnoo	Workplace Safety and Prevention Services (WSPS), Mississauga, Ontario <i>Category: General Interest</i>	
S. Bly	Health Canada, Ottawa, Ontario	<i>Associate</i>
B.A. Borst	3M Canada Company, London, Ontario	<i>Associate</i>
A.J. Brammer	Envir-O-Health Solutions, Gloucester, Ontario <i>Category: General Interest</i>	
S. Brown	WorkSafeBC, Vancouver, British Columbia <i>Category: Regulatory Authority</i>	
M. Chasin	Musicians' Clinics of Canada, Toronto, Ontario	<i>Associate</i>
J.M. Cousineau	Ontario Ministry of Labour, Toronto, Ontario <i>Category: Regulatory Authority</i>	
S. Donovan	MSA Canada Inc., Toronto, Ontario	<i>Associate</i>

R.A. Estok	Strongco Corporation, Mississauga, Ontario <i>Category: User Management</i>	
A. Fedée	Via Rail Canada Inc., Woodbridge, Ontario <i>Category: User Labour</i>	
W.J. Gastmeier	HGC Engineering (Howe Gastmeier Chapnik Ltd.), Mississauga, Ontario <i>Category: Producer Interest</i>	
A. Gaworski	MSA North America, Cranberry Township, Pennsylvania, USA	<i>Associate</i>
C. Giguère	University of Ottawa, Ottawa, Ontario <i>Category: General Interest</i>	
J. Goldberg	Custom Protect Ear, Inc., Surrey, British Columbia <i>Category: Producer Interest</i>	
G.P. Green	Nova Scotia Department of Labour and Advanced Education, Halifax, Nova Scotia <i>Category: Regulatory Authority</i>	
M. Gupta	Draeger Safety Canada Limited, Mississauga, Ontario <i>Category: Producer Interest</i>	
T. Harris	Unifor, Windsor, Ontario <i>Category: User Labour</i>	
E.A. Karpinski	Employment and Social Development Canada (ESDC) — Labour Program, Gatineau, Québec <i>Category: Regulatory Authority</i>	
S.E. Keith	Health Canada, Ottawa, Ontario <i>Category: Regulatory Authority</i>	
S. Lake	Colorado Springs, Colorado, USA	<i>Associate</i>

J. Maloney	International Brotherhood of Boiler Makers Local 128, Toronto, Ontario	<i>Associate</i>
T. Nicholls	Power Workers Union, Toronto, Ontario <i>Category: User Labour</i>	
M. Russo	Infrastructure Health and Safety Association, Mississauga, Ontario <i>Category: General Interest</i>	
T.Y. Schulz	Honeywell Safety Products, College Station, Texas, USA <i>Category: Producer Interest</i>	
J. Taylor	Taylor Lumber Company Limited, Middle Musquodoboit, Nova Scotia <i>Category: User Management</i>	
K.E. Turner	Protec Hearing Inc., Winnipeg, Manitoba <i>Category: Producer Interest</i>	
P. Malik	CSA Group, Toronto, Ontario	<i>Project Manager</i>
D. Shanahan	CSA Group, Toronto, Ontario	<i>Project Manager</i>

Subcommittee on Hearing Conservation Management

J. Goldberg	Custom Protect Ear, Inc., Surrey, British Columbia	<i>Chair</i>
A. Behar	Ryerson University, Scarborough, Ontario	
E.H. Berger	3M Personal Safety Division, Indianapolis, Indiana, USA	
I.B. Bhunnoo	Workplace Safety and Prevention Services (WSPS), Mississauga, Ontario	
S. Bly	Health Canada, Ottawa, Ontario	
B.A. Borst	3M Canada Company, London, Ontario	
S. Brown	WorkSafeBC, Vancouver, British Columbia	
J.M. Cousineau	Ontario Ministry of Labour, Toronto, Ontario	
J.R. Franks	LytleSound, Cincinnati, Ohio, USA	
A. Fedée	Via Rail, Toronto, Ontario	
S. Lake	Colorado Springs, Colorado, USA	
M. Russo	Infrastructure Health and Safety Association, Mississauga, Ontario	
T. Schulz	Honeywell Safety Products, College Station, Texas, USA	

K.E. Turner	Protec Hearing Inc., Winnipeg, Manitoba	
L. Wells	3M Corporation, St. Paul, Minnesota, USA	
P. Malik	CSA Group, Toronto, Ontario	<i>Project Manager</i>
D. Shanahan	CSA Group, Toronto, Ontario	<i>Project Manager</i>

Preface

This is the first edition of CSA Z1007, *Hearing loss prevention program (HLPP) management*.

This Standard sets out requirements for, and provides comprehensive guidance on, the management of HLPPs designed to protect individuals exposed to occupational noise.

This management system Standard is designed to serve as the basis for other CSA Group hearing conservation Standards. Once effective management for the HLPP is established using this Standard, professionals involved in the HLPP can use detailed requirements and application guidelines in those other Standards for specifying equipment and processes to be incorporated in the HLPP.

This Standard strikes a balance between the latest best practices in hearing loss prevention and current regulations in various Canadian jurisdictions. Some of the requirements, therefore, are more stringent than existing regulations. Each section in this Standard contains both normative clauses (where compliance is required or recommended) and informative clauses (providing explanatory information and best practices). For the most part, the informative clauses precede the normative clauses in each section.

By permission of Standards Australia and Standards New Zealand, AS/NZS 1269.0:2005 was used as a seed document for the development of part of this Standard.

By permission of The National Institute of Occupational Safety and Health, a division of the United States Center for Disease Control, parts of this Standard are based on *Criteria for a Recommended Standard: Occupational Hearing Conservation Program (Revised Criteria 1998)*, and *Preventing Occupational Hearing Loss — A Practical Guide*.

CSA Group acknowledges that the development of this Standard was made possible, in part, by the financial support of federal, provincial, and territorial governments' occupational health and safety agencies.

This Standard was prepared by the Subcommittee on Hearing Conservation Management, under the jurisdiction of the Technical Committee on Occupational Hearing Conservation and the Strategic Steering Committee on Occupational Health and Safety, and has been formally approved by the Technical Committee.

Notes:

- 1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
- 2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
- 3) *This Standard was developed by consensus, which is defined by CSA Policy governing standardization — Code of good practice for standardization as “substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity”. It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
- 4) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include “Request for interpretation” in the subject line:*
 - a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
 - b) *provide an explanation of circumstances surrounding the actual field condition; and*
 - c) *where possible, phrase the request in such a way that a specific “yes” or “no” answer will address the issue.*

Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization and are available on the Current Standards Activities page at standardsactivities.csa.ca.

- 5) *This Standard is subject to review five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line:*
- a) *Standard designation (number);*
 - b) *relevant clause, table, and/or figure number;*
 - c) *wording of the proposed change; and*
 - d) *rationale for the change.*

Z1007-16

Hearing loss prevention program (HLPP) management

0 Introduction

0.1 General

Noise is one of the most common occupational health hazards, and a widespread problem in many workplaces. Extended exposure to high noise levels presents a hazard to hearing. It can also have other adverse effects, such as interfering with speech communication, reducing perception of warning sounds, causing tinnitus, increasing stress, and cardiovascular effects (e.g., changes in heart rate, increasing blood pressure, and other systemic effects). Hearing loss has a significant impact on the worker's life for which professional advice and counselling might be necessary.

0.2 Elements of a hearing loss prevention program (HLPP) (see Figure 1)

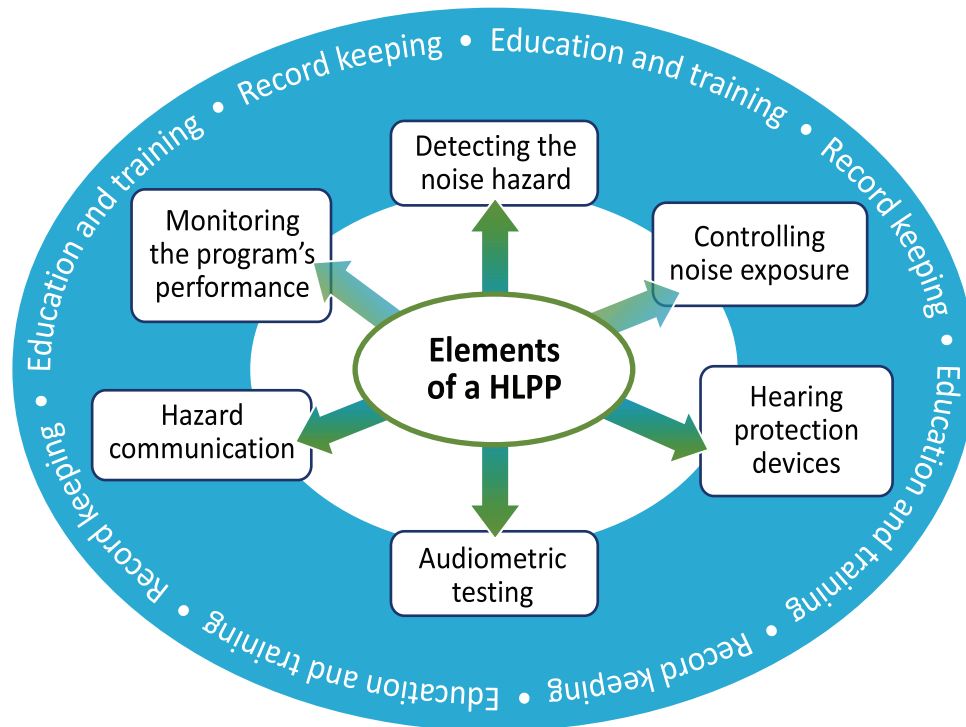
This Standard outlines the issues that an occupational hearing loss prevention program administrator (referred to hereinafter as the "administrator") needs to address to manage a program effectively. It is designed to guide the person charged with worker health and safety or the business owner in establishing and managing an HLPP. Where elements of the HLPP are addressed in other standards, this Standard mirrors those elements. This Standard also follows the "Plan, Do, Check, and Act" methodology detailed in Annex I.

An HLPP starts with the identification of a noise hazard. This can be as simple as noticing that it is hard to converse in a raised voice in an area or during a particular process. Once a noise hazard is suspected, the following processes are used to set up an effective HLPP:

- a) Perform noise exposure measurements throughout the workplace.
- b) Eliminate sources of hazardous noise.
- c) Employ engineering and/or administrative controls to reduce or eliminate worker exposure to hazardous noise.
- d) Employ noise hazard communication throughout the workplace.
- e) Educate and train the workforce on hazards of noise exposure, audiometric testing, and proper use of hearing protection devices (both on and off the job).
- f) Provide appropriate hearing protection devices.
- g) Perform audiometric testing.
- h) Keep records of all aspects of the HLPP.
- i) Implement a review process for the HLPP.

The ultimate goal is to prevent occupational hearing loss. Only by continuous improvement, pursued diligently by everyone involved, can this goal be approached.

Figure 1
Elements of a hearing loss prevention program (HLPP)
 (See Clause 0.2.)



0.3 Content of this Standard

Where possible, relevant clauses of the CSA Group Standards relating to the prevention of noise-induced hearing loss (NIHL) have been either incorporated or referenced in this Standard. In addition, annexes in this Standard provide

- an explanation of ototoxicity and its application to a hearing loss prevention program;
- further detail on what engineering the noise out of a facility entails;
- best practices in hearing loss prevention going beyond the recommendations and requirements of this Standard;
- examples of a noise map of a facility;
- the methodology of doing a risk assessment calculation;
- legislative context for hearing conservation (see also the CCOHS [Canadian Centre for Occupational Health and Safety] website: <http://www.ccohs.ca/>);
- information on the impact of unprotected exposures and how to modify an HLPP to account for them;
- a comparison and guidance for the various methods of estimating hearing protection device (HPD) attenuation;
- an explanation of the “Plan-Do-Check-Act” methodology;
- periodic assessment of HLPP performance sample worksheets;
- an explanation of dBA and dBC;
- details on the concept of auditory fitness (hearing ability) and its impact on the safety of the worker; and
- a sample of the hearing protection job compatibility analysis.

Note: Other CSA Group Standards provide detailed requirements for specific elements of an HLPP, while this Standard addresses management systems for an HLPP.

0.4 Legislative context

The specific parameters of hearing loss prevention regulations vary between Canadian jurisdictions. Many of these are listed in Annex F. Any differences between this Standard and regulations in any jurisdiction should be seen as reflecting an evolving understanding of this topic. Criteria and recommendations in this Standard assume that eliminating causes of hearing loss in the workplace is a fundamental goal of a hearing loss prevention program.

0.5 Sources of occupational hearing loss

Excessive noise exposure is the primary source of occupational hearing loss. (See Table 1.) General methods for noise hazard assessment, control, and mitigation have been extensively studied in past decades, and make up much of this Standard. However, other causes of hearing loss, such as ototoxic chemicals, can also be present in the workplace. These can combine with noise to create additive or synergistic effects. Much less is known about the potency of non-noise sources and the exact dose–effect relationship; nonetheless, this Standard provides basic information and guidance on these hazards.

Table 1
Noise comparison table
(See Clause 0.5.)

Examples of sound levels and permissible exposures			
Occupational	“Safe” durations for daily exposures*	Sound level (dBA)	Non-occupational
Revolver†	Unsafe	160	12 gauge shotgun†
	Unsafe	150	Firecracker†
Jet takeoff	< 1 s	140	Drag racing, in stands
Pneumatic riveter	1 s	130	50 hp siren (30 m)
Pavement breaker	9 s	120	Severe thunder
Riveter	1.5 min	110	Rock concert
Jackhammer	15 min	100	Chainsaw
Excavator/tractor	150 min	90	Belt sander
Portable air compressor	24 h	80	Electric lawn mower
Generator	Unlimited	70	Automobile (80 km/h)
Normal conversation	Unlimited	60	Dishwasher
Transformer	Unlimited	50	Window fan
Quiet office	Unlimited	40	Refrigerator hum
	Unlimited	30	Whisper
	Unlimited	20	Grand Canyon, remote trail
	Unlimited	10	Breathing
	Unlimited	0	Threshold of hearing

* Estimated values based on an 85 dBA permissible daily exposure with a 3 dB exchange rate. See Note below.

† Gunfire and impulses are very short sounds measured with a peak SPL reading that is different than the average SPLs used to rate the other sound exposures in this Table.

Note: The risk of harm due to loud sound depends on the sound level (measured in decibels), the duration of the exposure (measured in time), and personal susceptibility. Occupational regulations recognize that levels at or above 85 dBA can cause damage when the time of exposure equals 8 h or more per day; for each 3 dB increase in level the time of exposure is cut in half. For example: 85 dBA for 8 h is the same risk as 88 dBA for 4 h and 91 dBA for 2 h. See Annex F (Canadian legislative context) for further information.

Source: 3M Noise Navigator® found at www.e-a-r.com/hearingconservation (Berger, Neitzel, and Kladden).

0.6 Non-occupational exposures

Occupational hearing loss prevention programs rarely succeed without a suitable attitude and culture of hearing awareness (by both the organization and its workers). To develop awareness and create a culture of hearing preservation, training should emphasize hearing loss prevention both on and off the job. If the organization ignores non-occupational exposures, workers might doubt the sincerity of the organization's concern for their safety.

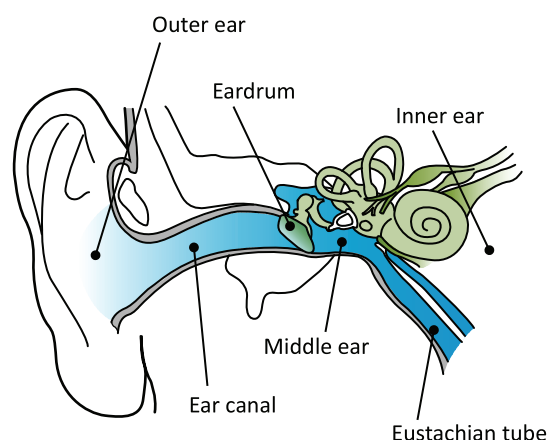
Therefore, a hearing loss prevention plan should educate workers on causes of hearing loss outside the workplace and the effects of unprotected exposures, and provide hearing protection devices for home and recreational use. Unprotected short-term, high-noise exposures can quickly result in a noise dose that exceeds the daily limit. Focusing on non-occupational exposures can help to promote a cultural shift, so that workers protect against all kinds of noise exposures out of their own awareness and understanding.

0.7 Effects of workplace noise and hearing loss prevention

Exposure to excessive occupational noise can cause permanent hearing loss through sensory-neural damage in the cochlea, the organ of hearing. Typically, hearing is first affected in a specific range of audible frequencies (3000 to 6000 Hz). Damage spreads to other frequencies over time and becomes more severe. Further, NIHL is often accompanied by other long-term auditory effects, such as tinnitus (ringing in the ears); increased sensitivity to loud noise; and poorer frequency selectivity (i.e., decreased ability to hear sounds in background noise) compared to individuals with normal hearing. High levels of noise in the workplace can also lead to temporary hearing loss and increased fatigue, affect job performance and productivity, and interfere with speech communication and with the detection of warning signals and other important sounds. In short, noise affects workplace safety and productivity, as well as hearing health.

A brief explanation of the function of the ear is helpful in order to describe how noise can affect and damage hearing. (See Figure 2.) Sound waves, collected by the pinna, or outer ear, pass along the ear canal and vibrate the eardrum (tympanic membrane), thereby transmitting vibrations through the bones of the middle ear to the cochlea. Each specific frequency causes vibration in specific "hair cells" in the cochlea, which in turn send nerve impulses to the brain as sound. Excessive noise exposure causes a reaction that damages these essential hair cells, causing a temporary or permanent loss in hearing.

Figure 2
Diagram of the ear
(See Clause 0.7.)



One of the conditions associated with exposure to noise is tinnitus (ringing in the ears). It is often worse when background noise is low — for example, when one goes to sleep at night in a quiet room. Tinnitus is common, and for most people, the condition is merely an annoyance. In severe cases, however, tinnitus can cause difficulty in concentrating and sleeping. Although one of the most common causes of tinnitus is NIHL, there are many other causes not related to noise or hearing loss.

In a noisy workplace, the auditory demands placed on the workers to maintain safety can be quite challenging. Operators of industrial equipment often need to be able to distinguish subtle variations in machinery noise to ascertain operation within safe limits, despite noise from other machines and industrial processes. All workers also need to be able to hear warning sounds alerting them to dangerous events or situations that require immediate attention. In addition, they also need to be able to communicate orally with others to react appropriately. Balancing these auditory demands with the use of hearing protection is challenging, especially in the presence of pre-existing hearing loss.

Reducing noise in the workplace provides both short-term and long-term hearing health benefits for workers, and promotes a safer and more productive work environment for everyone. As a first step, efforts should be taken to remove the noise hazard from the facility. Buying quieter machinery and engineering noise controls initiatives are strongly favoured, since they provide immediate benefits in all areas of hearing health and safety.

1 Scope

1.1 General

This Standard specifies requirements for the management of hearing loss prevention programs (HLPPs) designed to protect individuals from occupational hearing loss.

1.2 Subjects addressed

Following principles set out in CAN/CSA-Z1000, this Standard specifies requirements for

- a) management commitment, leadership, and participation;
- b) assignment of roles and responsibilities;
- c) identification and quantification of noise hazards;
- d) selection and application of controls;
- e) provision of protection (e.g., hearing protection devices);
- f) training, monitoring, and measurement (e.g., noise exposure and audiometric testing);
- g) documentation; and
- h) continuous improvement and management review.

1.3 Subjects not addressed

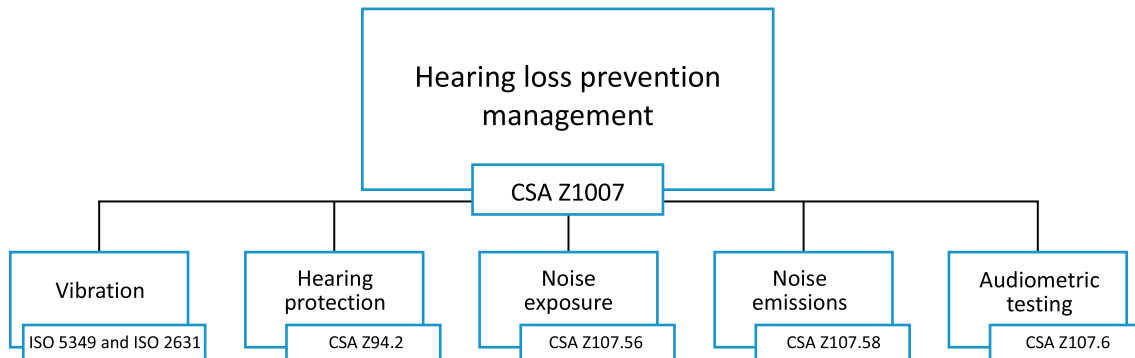
The following subjects are not addressed in this Standard:

- a) psychological effects of exposure to noise;
- b) non-auditory effects of noise exposure; and
- c) non-industrial noise exposure except as it impacts industrial noise exposure.

1.4 Relation to other Standards

This Standard is part of CSA Group's Z1000 series of Standards on management of occupational health and safety. (See Figure 3.) As such, it is based on the OHS management principles in CAN/CSA-Z1000.

Figure 3
Hierarchy of hearing conservation Standards
 (See Clauses 1.4 and 3.)



This Standard is intended to be used with related occupational or technical standards, and referenced by other Standards as the primary set of requirements for management of HLPPs.

Note: *This Standard reflects practices in hearing loss prevention that are current at the time of publication, and is based on more recent information than some older regulations. As a result, in some subject areas, this Standard is more stringent than current provincially legislated regulations.*

This Standard complements other CSA Group hearing loss prevention Standards, as follows:

- a) Z94.2 for hearing protection;
- b) Z107.56 for measurement of occupational noise exposure;
- c) Z107.6 for audiometric testing for use in hearing loss prevention programs; and
- d) Z107.58 for noise emission declarations for machinery.

Once an effective management process is established for the HLPP, these other Standards will provide the information needed to detail the program's requirements.

1.5 Applicability

This Standard is designed for use in Canadian workplaces. The principles established in this Standard are based on internationally recognized practices.

1.6 Users' responsibility

Hearing loss prevention legislation differs from jurisdiction to jurisdiction in Canada. It is the users' responsibility to determine how applicable legislative requirements relate to this Standard.

1.7 Terminology

In this Standard, "shall" is used to express a requirement, i.e., a provision that the user is obliged to satisfy to comply with the standard; "should" is used to express a recommendation or that which is advised but not required; and "may" is used to express an option or that which is permissible within the limits of the standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

2 Reference publications

This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below.

CSA Group

Z94.2-14

Hearing protection devices — Performance, selection, care, and use

CAN/CSA-Z94.4-11

Selection, use, and care of respirators

Z107.6 (under development)

Audiometric testing for use in hearing loss prevention programs

Z107.56-13

Measurement of noise exposure

Z107.58-15

Noise emission declarations for machinery

CAN/CSA-Z1000-14

Occupational health and safety management

CAN/CSA-Z1002-12

Occupational health and safety — Hazard identification and elimination and risk assessment and control

ANSI (American National Standards Institute)

ANSI S1.4-1983 (R2006)

Specification for Sound Level Meters

ANSI S3.19-1974 (withdrawn, but still enforced by requirements of the U.S. Environmental Protection Agency)

Method for the Measurement of Real-Ear Protection of Hearing Protectors and Physical Attenuation of Earmuffs

ANSI/ASA (American National Standards Institute/Acoustical Society of America)

ANSI/ASA S12.6-2008

Methods for Measuring the Real-Ear Attenuation of Hearing Protectors

ANSI/ASA S12.71 (under development)

Performance Criteria for Systems Designed to Estimate the Attenuation Obtained By Individual Users of Passive Hearing Protectors

AS/NZS (Standards Australia/Standards New Zealand)

1269.0:2005

Occupational noise management — Part 0: Overview and general requirements

EC (European Commission)

Vibration Directive 2002/44/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration)

IEC (International Electrotechnical Commission)

60034-9:2003

Rotating electrical machines — Part 9: Noise limits

61672-1:2013

Electroacoustics — Sound level meters — Part 1: Specifications

ISO (International Organization for Standardization)

2631-1:1997

Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements

5349-1:2001

Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 1: General requirements

5349-2:2001

Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 2: Practical guidance for measurement at the workplace

15664:2001

Acoustics — Noise control design procedures for open plant

Other publications

Note: Refer also to the following:

- a) Canadian Centre for Occupational Health and Safety (CCOHS). Occupational Noise;
- b) Council for Accreditation in Occupational Hearing Conservation (CAOHC). Hearing Conservation Manual, 4th Edition, Third Printed (2010); and
- c) Giguère, C. and Laroche, C. Hearing loss prevention program in the military environment. Canadian Acoustics, Vol 33, No. 4 (2005).

American Conference of Governmental Industrial Hygienists (ACGIH). *Threshold Limit Values for Chemical Substance and Physical Agents — 2015*.

American Industrial Hygiene Association (AIHA). *The Noise Manual*. Revised Fifth Edition, 2003.

Berger, E.H. 1993. The Naked Truth About NRRs. *EarLog* 20.

Gauger, D., and Berger, E. H. (2004). "A New Hearing Protector Rating: The Noise Reduction Statistic for use with A Weighting (NRS_A)". A report prepared at the request of the U.S. Environmental Protection Agency, reviewed and approved by ANSI S12/WG11, E-A-R 04-01/HP.

Health Canada. August 2010. *Notice to Stakeholders — Subject: Noise from Machinery Intended for the Workplace*.

NIOSH (National Institute for Occupational Safety and Health). DHHS (NIOSH) Publication Number 96-110. *Preventing Occupational Hearing Loss — A Practical Guide* (1996).

NIOSH (National Institute for Occupational Safety and Health). DHHS (NIOSH) Publication Number 98-126. *Criteria for a Recommended Standard: Occupational Noise Exposure (Revised Criteria 1998)*.

NIOSH (National Institute for Occupational Safety and Health). DHHS (NIOSH) Publication Number 2009-136. *Preventing Occupational Exposures to Lead and Noise at Indoor Firing Ranges* (2009).

U.S. Environmental Protection Agency (EPA). 1979. 40CFR Part 211, Subpart B. Product Noise Labeling — Hearing Protective Devices. (Based on the test method found in ANSI S3.19-1974, *Method for the Measurement of Real-Ear Protection of Hearing Protectors and Physical Attenuation of Earmuffs* [withdrawn].)

3 Definitions

The following definitions shall apply in this Standard:

A-weighted sound level, dBA — the frequency-weighted value, measured in decibels, of the sound level with the weighting de-emphasizing the frequency extremes, especially the low frequencies below 250 Hz (middle C), and emphasizing the frequencies around 2500 Hz to approximate human hearing sensitivity at moderate sound levels (see Annex K).

Note: Refer to IEC 61672-1 for the actual weighting values.

Action level — a specified value of sound pressure level or exposure that requires certain actions when a measurement equals or exceeds it (e.g., the level at which implementation of an HLPP is mandated).

Active noise reduction (ANR) hearing protection device — an electronic device that provides hearing protection by using out-of-phase sound waves to reduce noise at the ear by destructive interference.

Activity — elements of a worker's work shift that represent different noise exposure conditions during the work shift. Each activity consists of one or more work tasks or events that can be definitely recognized and have specific beginning and ending points.

Administrative controls — changes in the work schedule or operation that reduce a worker's noise exposure by limiting the amount of time that the worker is exposed to noise.

Attenuation — the reduction in sound pressure incident upon the ear due to the application of a hearing protector, which can be estimated by measuring the change in hearing threshold level that results when a hearing protector is worn.

Audiogram — a graph or chart presenting hearing threshold level as a function of frequency, measured with an audiometer.

Audiometric technician — a person who conducts audiometric testing and has successfully completed a training course, as outlined in CSA Z107.6, and can demonstrate competency to that effect.

Note: In many jurisdictions, audiometric technicians are required to be certified or licensed to practice this profession.

Audiometric tests — air-conduction hearing tests in which workers respond to pure-tones in order to determine their hearing threshold levels.

Baseline audiometric test — the first test individuals have just before or immediately after starting work in a hazardous noise environment; it typically serves as the reference test against which subsequent monitoring audiometric test results are compared.

Buy Quiet — a safety and health initiative to select and purchase the lowest noise-emitting power tools and machinery in order to reduce occupational and community noise exposure.

C-weighted sound level, dBC — the frequency-weighted value, measured in decibels, of the sound level with the weighting de-emphasizing the frequencies at and below 31 Hz and at and above 8000 Hz (see Annex K).

Note: Refer to IEC 61672-1 for the actual weighting values.

Communication headset — an earplug or earmuff, with a built-in speaker, that is designed primarily for communication, but which can also provide hearing protection.

Daily exposure level ($L_{EX,8}$) — the sound exposure averaged over 8 h.

Decibel (dB) — a unit of measurement used to express sound pressure levels where the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power.

Dosimeter — an instrument, often pocket-sized, designed to be worn during all or part of the day as a personal monitor in order to measure the wearer's noise exposure.

Note: For a detailed description of noise dosimeters, see Clause 4.1.2 of CSA Z107.56.

Earmuff — a hearing protector usually consisting of a headband and ear cups with a soft outer ring or cushion intended to fit snugly against the pinna (supra-aural) or the sides of the head around the pinna (circumaural).

Earplug — a hearing protector worn within the external ear canal (an insert or aural earplug) or in the concha against the entrance to the external ear canal (a semi-insert or semi-aural earplug).

Employer — a person who employs (or contracts for the services of) one or more workers, including temporary workers, and is responsible for preparing and implementing an HLPP at the facility provided that one is required.

Engineering controls — measures such as modifying or replacing equipment, or making related physical changes at the noise source or along the transmission path to reduce the noise level at the worker's ear.

Equivalent A-weighted sound level ($L_{eq,T}$) — equivalent, continuous A-weighted sound level (also called "average sound level"), during the time period T, using a 3 dB exchange rate.

Note: The equivalent sound level is identical to the sound level of a constant sound of the same total A-weighted acoustical energy as the actual varying sound of interest over the same time period.

Exchange rate (Q) — the increase (decrease) in sound level for which permissible exposure time is halved (doubled).

Note: The two common exchange rates used are 3 dB (as specified in the Standards listed in Figure 3) and 5 dB. Even where the 5 dB exchange rate is required in a Regulation, it is recommended that the 3 dB exchange rate be used as well since it provides a higher degree of protection (for exposure of 8 h or less).

Field attenuation estimation system (FAES) — a system for estimating the attenuation of a hearing protection device obtained by the wearer during the time of measurement.

Hazardous noise — sound that has the potential for harming the hearing of the exposed person (and can include loud music).

Note: Generally, it is accepted that $L_{EX,8} > 80$ dBA is a hazardous noise.

Health care professional — an individual who is licensed by a provincial licensing authority (or equivalent) to practice medicine, audiology, or nursing, and who possesses experience and knowledge in the field of occupational health and safety.

Hearing protection device (HPD) — a personal protective device, also referred to as a hearing protector, worn to reduce the sound level reaching the eardrum (tympanic membrane).

Hearing protection job compatibility analysis — a process used to decide which hearing protector types should be included in the HLPP. To perform the analysis, the administrator needs to understand the job functions, noise exposure, and other personal protective equipment of the workers (see Annex M).

Hearing protector class — a classification that specifies the attenuation of a hearing protector in terms of a letter, A, B, or C, as derived from ANSI S3.19 experimenter-fit data. The class pertains only to the attenuation performance of the device, not to any of its other characteristics.

Integrating sound level meter — an electronic instrument designed to measure $L_{eq,t}$.

Note: These meters normally incorporate the following characteristics:

- a) an A-weighting network;
- b) a dynamic range of 50 dB or more;
- c) a crest factor capability of 30 dB or more; and
- d) Class 1 or 2 tolerance (in accordance with IEC 61672-1) or Type 1 or 2 (in accordance with ANSI S1.4).

L_{Aeq} — A-weighted, equivalent sound level. It is a widely used noise parameter describing a sound level with the same A-weighted energy content as the varying acoustical signal measured.

Note: This term is also written as " L_{eq} ".

L_{Ceq} — C-weighted, equivalent sound level. It is an infrequently used noise parameter describing a sound level with the same C-weighted energy content as the varying acoustical signal measured.

L_{eq} — see **Equivalent A-weighted sound level**.

Monitoring audiogram — the periodic test that is compared to the reference test to determine whether or not a shift in hearing thresholds has occurred since the time of the reference test.

Noise exposure level ($L_{EX,8}$) — the equivalent sound exposure level; the steady sound level in dBA which, if present in a workplace for 8 h/day, would contain the same total energy as that generated by the actual and varying sound levels to which a worker is exposed in their total workday, however long or short.

Noise-induced hearing loss (NIHL) — a disorder that typically results from exposure to high noise levels over a long period of time.

Note: NIHL is a preventable hearing disorder that affects people of all ages and demographics.

Noise reduction rating (NRR) — a single-number rating that indicates the overall hearing protector attenuation, computed as the difference between the C-weighted level of a noise spectrum having equal energy per octave band and the A-weighted noise levels under a hearing protector, using mean

attenuation data less two standard deviations, derived from the U.S. EPA's interpretation of the experimenter-fit procedure of ANSI S3.19.

Note: *This method continues to be used by the U.S. EPA (see 40CFR 211, Subpart B). NRR needs to be derated before use as it is acknowledged to overestimate the actual performance of the HPD in practice (see Clause 7.12.3).*

Occupational hearing loss — a loss of hearing related to the individual's exposure to hearing-hazardous agents such as noise, certain chemicals, whole-body vibration, and other agents, where exposure to such agents occurs as part of the individual's occupational environment.

Octave bands — a band of frequency such that its upper cut-off is twice the lower frequency cut-off.

Organization — a company, operation, undertaking, establishment, enterprise, institution, or association, or a part or combination thereof, that has its own management. An organization can be incorporated or unincorporated, public or private.

Note: *For organizations with more than one operating unit, a simple operating unit may be defined as an organization.*

Ototoxic — a type of chemical agent that can cause damage to the inner ear.

Personal attenuation rating (PAR) — the rating for a given hearing protection device used to estimate the noise attenuation the device provides for an individual.

Presbycusis — impairment of hearing with age.

Qualified person — an individual who possesses the knowledge, experience, and training to fulfill the competencies of the role(s) defined in this Standard.

Reference audiogram — the audiometric test against which monitoring audiometric tests are compared.

Note: *Typically, the reference audiometric test is the baseline test, but it might be another previously obtained test if used for comparison purposes.*

Risk rating — a method of assessing the risk to hearing of noise exposure as specified in Clause 5.5 and Annex E.

Service provider — a qualified person or organization having expertise in one or more of the aspects of the design and development of hearing loss prevention programs, including exposure assessment, risk assessment, engineering and administrative control management, training, and monitoring or development of occupational health and safety programs for continuous improvement.

Single number rating (subject fit 84th percentile) [SNR(SF₈₄)] — the difference between the overall C-weighted level of a noise spectrum having equal energy per octave and the A-weighted noise levels under a hearing protector, computed using mean attenuation data less one standard deviation.

Note: *When derived from ANSI/ASA S12.6, Method B (inexperienced subject fit), this SNR rating provides a nominal protection performance of 84% of the subject population.*

Sound level meter — an electronic instrument designed to meet at least the Type 2 requirements of IEC 61672-1 or ANSI S1.4 and is used on the A-weighting network and on slow response.

Sound power level or acoustic power level (L_W) — a measure of the sound power in comparison to a specified reference level.

Notes:

- 1) Sound pressure level is denoted as " L_p " and expressed in decibels relative to 20 μPa . Sound power is denoted as " L_W " and expressed in decibels relative to 10^{-12} W. While sound power level reflects the total acoustic energy output of a source, the sound pressure level reflects the amount of that energy impinging upon a point in space (such as the microphone of a sound level meter).
- 2) In the past, sound power level was denoted "SWL", rather than " L_W ". "SWL" is no longer a recognized abbreviation.

Sound pressure level (L_p) — 10 times the base-10 logarithm of the ratio of the mean-square pressure of a sound, in a stated frequency band, to the square of the reference sound pressure (20 μPa), normally expressed in decibels (see **Decibel**).

Note: In the past, sound pressure level was denoted "SPL", rather than " L_p ". "SPL" is no longer a recognized abbreviation.

Sound restoration device — a hearing protector that includes electronic components and is designed to exhibit a change in attenuation as a function of sound level.

Note: This device is also referred to as a "level-dependent protector".

Target exposure limit — the maximum noise exposure (or noise dose, usually expressed as " L_{EX} ") for workers as set by the organization (employer).

Note: The target exposure limit will be no greater than the maximum exposure level set by applicable OHS regulations.

Temporary threshold shift — the recoverable hearing loss that results from exposure to high-level impulse or continuous sound, as opposed to the irreversible permanent threshold shift that can result from such exposure.

Threshold shift — a change in hearing threshold at a specified frequency from a threshold previously established. The amount of threshold shift is expressed in decibels.

Tinnitus — a sensation of hearing a ringing or buzzing sound in the ear in the absence of an actual sound (sometimes characterized as hissing or whistling).

4 Persons involved in the hearing loss prevention program (HLPP)

4.1 Requirement for a hearing loss prevention program

Every organization shall consider whether or not workers are subject to hazardous noise exposure. If workers are subject to hazardous noise exposure, the organization shall establish, implement, and maintain a hearing loss prevention program (HLPP) in accordance with this Standard.

Notes:

- 1) Assessment of risk of hearing loss and risk mitigation measures are integral parts of a compliant HLPP.
- 2) As a preventive measure, organizations may choose to establish an HLPP even if none of their employees are presently subject to hazardous noise exposure.

4.2 Responsibilities

The development and implementation of an HLPP is usually a shared process. It could be the responsibility of a team of professionals vetted and coordinated by a program administrator, or it could be administered by a business owner with the aid of service providers. The number of team members,

and their professional disciplines, can vary with the kind of organization and the number of noise-exposed workers. Team members can include management, staff, and professionals such as audiologists, physicians, occupational health nurses, occupational hearing conservationists, engineers, industrial hygienists, safety professionals, management representatives, and worker and union safety representatives (e.g., OHS committees). They can be organization employees, or service providers contracted to develop and implement the HLPP. This Standard provides a road map for the development of the HLPP.

4.3 Organization's/management's role

For an HLPP to succeed, the employer or owner, management, and supervisors shall communicate and behave in a way that signals the program's importance. They set the tone, develop the policy, and give the program's requirements priority. They also set an example for their workers by their conformance with the tenets of the HLPP. Only then can the hearing loss prevention program administrator make the program effective.

4.4 Hearing loss prevention program administrator

The administrator shall act as champion for the program, assuming overall responsibility for its implementation, correcting deficiencies, enforcing compliance, and focusing management's attention when change or resources are required.

Note: *In smaller organizations, a senior manager (capable of competently carrying out the responsibilities listed in Clause 4.12) may act as the program administrator.*

4.5 Occupational health and safety committees and worker representatives

Where there is a group of individuals or a representative reporting on the effectiveness of the health and safety programs within the organization, the OHS committee or representative shall report to organization management on the effectiveness of the HLPP (see Clause 11 and Annex C).

4.6 Role of workers

While the employer has the primary responsibility for controlling workplace noise and reducing workers' exposure to hazardous noise, hearing loss prevention is a shared responsibility between management and workers (see Clauses 4.9 and 4.10).

4.7 Roles of contractors and temporary/transient worker agencies

As specified in Clause 4.1, in any workplace where workers are subject to hazardous noise exposure, all workers (including contract workers) shall be subject to an HLPP. The organization shall ensure that all contractors and agencies providing employment for temporary workers to the organization have or set up an HLPP which covers their employees.

Visitors to a workplace shall be informed by the workplace owner or manager of any areas or activities containing hazardous noise (to which they might be exposed) and be required to use hearing protection within those areas.

Contractors and agencies providing employment for temporary workers take on the role of the administrator with respect to those they employ. As these workers might not have another advocate, contractors and agencies should confirm that all aspects of this Standard are in place and functional when they provide workers to various workplaces where hazardous noise could exist.

4.8 Other participants

4.8.1 General

In developing and managing the HLPP, it is preferable to have as many roles as possible filled by workers (i.e., competent individuals employed by the organization). When the expertise is not available within the organization, and it is not feasible to hire a person with such expertise, external service providers should be contracted to fulfill the remaining roles, as detailed in Clauses 4.4 and 4.8.2.

4.8.2 Hearing loss prevention program external service providers

These external service providers have expertise in one or more aspects of the design and development of programs, including: noise mapping, exposure assessment, risk assessment, engineering and administrative control design and management, training, monitoring, or development of occupational health and safety programs for continuous improvement. Qualified external service providers often have designations such as Canadian Registered Safety Professional (CRSP), Certified Industrial Hygienists (CIH), Registered Audiologist, Registered Occupational Hygienists (ROH), or professional engineers with relevant experience.

4.9 Organization's responsibility

Organizations shall control noise in the workplace and provide all the tools to protect the hearing of their workers and affiliates carrying out duties assigned to them by the organization.

4.10 Workers' responsibility

In order for an HLPP to be successful in preventing hazardous noise exposure, it is necessary that individual workers co-operate and play an active role in that effort. In fulfilling this responsibility, workers shall avoid exposing themselves to known sources of hazardous noise and, where this is not practicable, use hearing protection (as provided by the employer) to attenuate the noise reaching their ears. Workers shall also participate in hearing loss prevention training provided by the employer, identification and control of hazardous noise sources, and audiometric testing. In addition, they should be encouraged to give feedback to management on concerns about the HLPP and opportunities for its improvement (see Annex J).

4.11 Contractors' and temporary/transient worker agencies' responsibilities

Contractors and agencies should maintain HLPP records for use (where permitted) by subsequent employers (see Clause 12.3.1).

4.12 Hearing loss prevention program administrator responsibilities

The administrator shall administer the HLPP so that it meets the requirements of this Standard, ensuring that

- a) qualified personnel have been assigned the roles defined in this Standard, and that each has the training required to carry out their roles within the HLPP before assuming those roles;
- b) if an external service provider is contracted, they have relevant competency and a proven record of success;
- c) noise controls required by the HLPP, including engineering and administrative controls, are provided and maintained;
- d) results of exposure assessments and control plans are shared with affected workers;
- e) all persons exposed to hazardous noise levels receive training and education (see Clause 10);
- f) all persons exposed to hazardous noise levels are able to demonstrate ongoing competency in hearing protection use and receive additional training where required;

- g) audiometric testing is done in accordance with Clause 8 and performed in accordance with CSA Z107.6;
Note: For details about audiometric testing not contained in this Standard, reference should be made to CSA Z107.6.
- h) corrective actions are taken when the periodic assessment of HLPP performance (see Annex J) reveals changes to previous levels that require adjustments to the tenets of the HLPP;
- i) corrective actions are taken when audiometric testing reveals hearing loss consistent with occupational noise exposure;
- j) problems are detected and corrective actions are formulated, implemented, and documented;
- k) progress on the performance of the HLPP is documented and reported to management, workers, and worker representatives (e.g., OHS committees) for review purposes and as a basis for improvement;
- l) the HLPP is following the guidelines in this Standard for continuous improvement (see Clause 11 and Annex J); and
- m) written instructions and records required by this Standard are maintained for the specified periods of time (see Clause 11.6).

4.13 Management of service providers

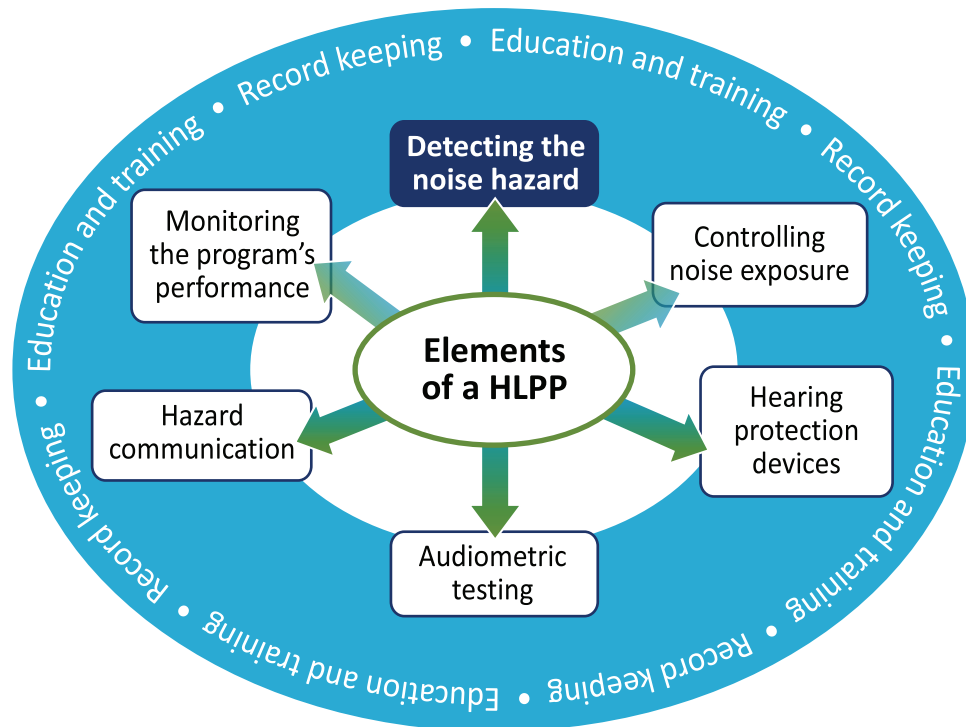
If the decision is made to contract out all or part of the HLPP, including the management of the entire program, the organization shall establish and maintain procedures for

- a) setting measurable objectives for the program or elements of the program to achieve as measurement of the performance of the program, and assessing the program according to these objectives;
- b) evaluating and selecting service providers in accordance with this Standard;
- c) ensuring that the service providers meet or exceed the organization's program requirements; and
- d) identifying hazards, assessing risks, and eliminating or controlling hazards and risks related to the activities, equipment, and materials of the organization and of service providers and others that enter into contracts with the organization.

4.14 Audiometric technician

An audiometric technician (as defined in Clause 3), who has successfully completed a training course as outlined in CSA Z107.6, shall perform audiometric testing. This testing may be contracted to qualified service providers (see Clause 8.3 of this Standard for a list of specific responsibilities).

5 Detecting hazards and assessing risk



5.1 Overview and theory

5.1.1

As specified in Clause 4.9, organizations have the primary responsibility for protecting their workers from noise levels that can be hazardous to their hearing. An HLPP therefore starts with identifying and quantifying the noise hazard. Limits to noise exposure are laid out in Clauses 5.2 to 5.9, Clause 6.2.1, and Annex F.

5.1.2

There are three basic steps for quantifying the noise hazard, each with its own utility. The first step is an overview of the entire facility. This can be done by a preliminary walk through the facility and determining areas where interpersonal communication is challenged (e.g., interpersonal communication requires shouting at a distance of 1 m).

5.1.3

When potentially hazardous noise is detected, the second step is to quantify the noise levels and identify the equipment and activities contributing to it. This is useful when developing a plan for engineering methods of eliminating or reducing the noise hazard. It is useful to determine the noise level at each workstation, particularly for processes that have multiple locations for an operator or multiple operators. This determines who in the facility performs a task or operates equipment that is noisy. It also helps to identify at which workstations or for which tasks hearing protection will always be required.

In simple cases, this can be done with a noise level survey (see Clause 5.3) that maps sound levels in the facility.

In more complex situations, this information is often best collected using the procedure for measurements of noise exposure using the integrating sound level meter described in Clause 6.5 of CSA Z107.56. Similar information can also often be obtained and documented by annotating the output of a logging dosimeter with the person who has worn it to identify the areas and activities contributing to their noise exposure. In such cases, this information can be obtained during the noise exposure measurements.

5.1.4

The third step for quantifying a noise hazard is to determine the actual exposure of those working in the noise hazard or at hazardous workstations (see Clause 5.4). It is this noise exposure that is essential for developing the HLPP.

By quantifying noise exposures and the relative contributions of the noise sources contributing to this exposure, the hazard will be quantified.

5.1.5

Because the HLPP applies where workers are subject to hazardous noise exposure, it follows that workers' exposure to noise shall be monitored on a regular basis (e.g., every two years). Monitoring also shall be repeated whenever there is a significant change of noise exposure (e.g., changes in work assignment, machinery/equipment, production processes, or maintenance routines). It might also be prudent to assess noise exposures when work practices have changed or if workers are developing hearing threshold shifts.

5.2 Noise source identification

A floor plan is helpful in showing all noise sources as illustrated in Annex D. The location of workers that spend most of their time at a machine or process can be marked on the floor plan to clarify the possible number of those exposed.

The next step is to measure the noise levels in the workplace from equipment, processes, and tasks. There are two basic types of measurements: the noise level survey and noise exposure measurement. Each is described in Clauses 5.3 and 5.4, respectively.

5.3 Noise level survey

The purpose of a noise level survey is to identify possible sources of hazardous noise. The noise levels are used to

- a) determine the need for an HLPP;
- b) identify jobs for which noise exposure measurements are needed;
- c) assist with noise source identification and their contribution to noise exposure;
- d) assess effectiveness of engineering controls and other control methods; and
- e) define areas where hearing protection devices might be required.

In simple cases, mapping of sound levels can be sufficient to accomplish this goal. Annex D provides an example of a noise map.

If a noise exposure measurement is being done which also identifies the sources of noise as described in Clause 5.1.3, the noise level survey may be optional.

Sound levels can vary throughout a work shift or equipment cycle as well as in different areas. Measurements can be taken using the procedure for measurements of noise exposure using the integrating sound level meter described in Clause 6.5 of CSA Z107.56, or by annotating the output of a logging dosimeter with the person who has worn it to identify the areas and activities contributing to

their noise exposure either on a drawing or in a table. This information can be used to quantify the contributions of various areas, equipment, and activities to worker noise exposure.

Noise level surveys are often contracted to qualified persons familiar with these requirements and shall be done in accordance with CSA Z107.56.

5.4 Noise exposure measurement

The purpose of the noise exposure measurement is to quantify typical noise exposure to the worker over the entire work shift. It integrates sound level over the time of the exposure. Typically this is done by using a noise dosimeter, or by creating a noise exposure profile or task-based assessment using an integrating sound level meter.

A worker's noise exposure shall be determined in accordance with CSA Z107.56. The noise exposure measurements should also be used to identify which noise sources and activities contribute most to employee noise exposure, quantify these contributions, and prioritize noise control strategies. Noise exposure information is particularly important for mobile workers and work areas/procedures with variable noise levels. Noise exposures are used to determine which workers are to be included in the HLPP and for the selection and use of hearing protection devices.

Noise exposure measurements are often contracted to qualified persons familiar with these requirements and shall be done in accordance with CSA Z107.56.

Note: *Noise exposure surveys are an element of noise exposure measurements.*

5.5 Risk assessment

A risk assessment should be done to develop priorities for action within the HLPP for various areas in the facility. It should be based on noise source identification and noise exposure results, the number of workers present in the noise field, and data analysis and evaluation. An example of a risk rating procedure is provided in Annex E.

Note: *CAN/CSA-Z1002 and Annex E of this Standard provide general principles of risk assessment.*

5.6 Ototoxicity

For the purposes of the HLPP, in consideration of the etiology understood at this time (see Annex A), it is prudent to reduce the concentrations of ototoxic substances below the occupational exposure limits as set by the authority having jurisdiction by elimination, substitution, ventilation, and other engineering controls. Appropriate personal protective equipment should be used to control dermal and inhalation exposures (see Clause 5.8). HPDs do not provide protection from ototoxic agents. For this reason, inhalation and dermal exposures to these agents should also be controlled to help prevent hearing damage (see Clause 5.8 and Annex A).

Note: *There is no conclusive correlation between ototoxic exposure at the levels mandated by current worksite standards and hearing loss. Nevertheless, it is prudent to treat conditions wherein ototoxic exposure is in combination with noise exposure such that the ototoxic exposure is lessened below current environmental standards and the target exposure limit under-the-protector is reduced by 3 dB.*

5.7 Whole-body and hand-arm vibration exposure and hearing loss

Vibration exposure is similar to noise exposure but is due to vibration transmitted directly through a solid structure to the worker's body, rather than through the air, and often affects parts of the body other than the ear. There is also evidence that persons who operate noisy, vibrating tools or machines and develop neurological or vascular disturbances in the fingers (e.g., "vibration-induced white finger" or "hand-arm vibration syndrome") are at greater risk of developing hearing loss. The effect has been

documented even when hearing protection is worn. It is not known whether the cause of excess hearing loss, which is commonly at high frequencies, results from individual susceptibility or the potentiating, or synergistic, interaction of noise and vibration. Regardless, there are good reasons for limiting exposure to vibration to prevent injury to the spine and organs and white-finger (Raynaud's) disease.

The EC Vibration Directive sets out European regulations for the exposure of workers to hand-arm vibration (HAV) and whole-body vibration (WBV) in the workplace. These are widely referred to in Canada, as are ACGIH and NIOSH vibration criteria. All three refer to ISO 2631-1 and ISO 5349 (Part 1 and Part 2), which outline the weightings and the required instrumentation to be applied to measure and assess whole-body and hand-arm vibration exposure, respectively, and also recommend criteria.

Instrumentation conforming to these Standards is available to rent or purchase from several suppliers. Many suppliers of mobile equipment and industrial power tools can provide measurements of the vibration produced by their products and have introduced measures to reduce users' vibration exposure. Before comparing these measurements to the selected criteria, the administrator should ensure that they were taken using the correct weightings prescribed by ISO 2631-1 and ISO 5349 (Part 1 and Part 2).

HLPPs should be extended to persons exposed to vibration above the EC, ACGIH, or NIOSH criteria. This shall include instituting engineering controls wherever they are reasonably feasible, monitoring worker exposure, and more frequent training and inspection of work practices. As recommended in Clause 8.2.3.1 d), monitoring audiograms for such workers should be conducted more frequently.

5.8 Influences in combination

While ototoxicity and vibration have not been quantifiably linked to noise-induced hearing loss (NIHL), the combination of one or both of these influences with hazardous noise should be treated differently. The administrator should reduce the action level where workers are subject to a combination of hazardous noise exposure and exposure to ototoxic chemicals or whole-body vibration by 50% (e.g., by 3 dBA $L_{EX,8}$).

5.9 Noise exposure versus noise level

As specified in Clause 5.5, NIHL risk is calculated based on hazardous noise exposure, not on ambient noise level (see CSA Z107.56). In order to properly select a hearing protection device (HPD) for a given noisy environment, only the noise exposure measurement ($L_{EX,8}$ dose using a 3 dB exchange rate) shall be used (i.e., equivalent full-shift values). See Clause 7.3 for details on HPD selection criteria (based on similar criteria in CSA Z94.2).

5.10 Calculation of $L_{EX,8}$

It is necessary to be able to compare noise exposure levels for workers from shift to shift, location to location, and plant to plant. This is done by calculating the steady-state noise exposure level over 8 h that would be equivalent to the varying noise exposures workers experience in their day. Throughout this Standard, this noise exposure level is referred to as $L_{EX,8}$.

5.11 Adjustments for length of work shifts

For the purposes of this Standard, "noise-exposed individuals" are those whose noise exposure is

greater than 85 dBA $L_{EX,8}$. However, extended work shifts (e.g., 12 h/day shifts) are becoming more common in many workplaces. In such cases, several factors shall be considered, including

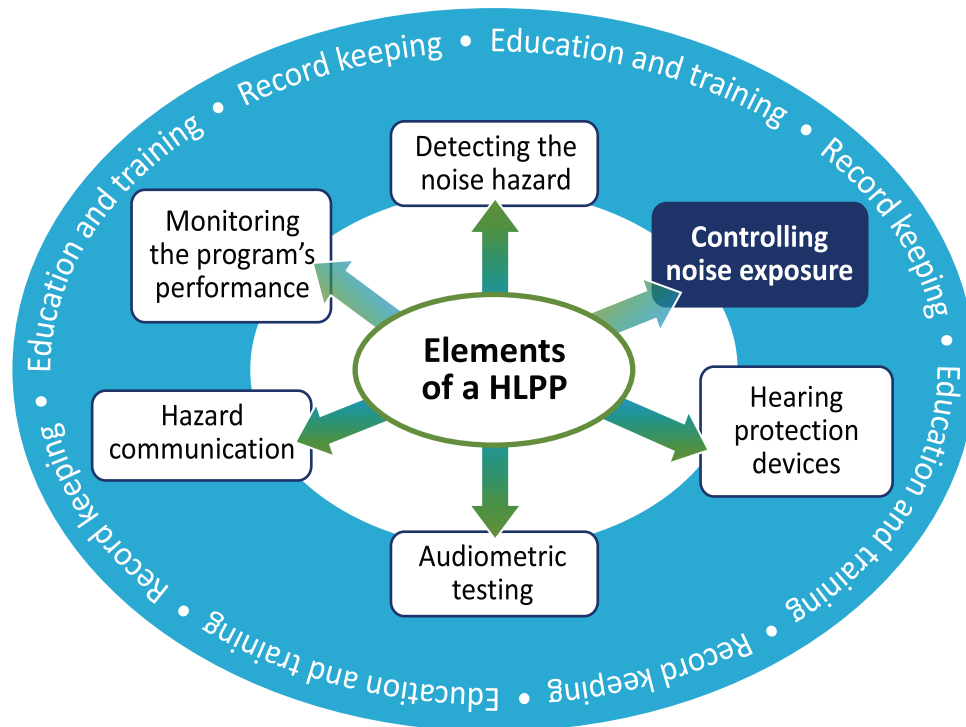
- a) adjustment of 8 h time-weighted average exposure values to durations longer than 8 h (see Table 2);
- b) longer use of HPDs during the work period, and the problem associated with the comfort of the HPD; and
- c) shorter rest periods between noise exposures (and thus shorter periods of recovery for the sensory organs of the ear between exposures).

Harmful effects of noise result from exposure to sustained levels, as well as from exposure to discrete high-level noise events. It is necessary to keep daily exposure to less than or equivalent to an $L_{EX,8}$ of 85 dBA. Table 2 gives examples of continuous exposures and durations that result in $L_{EX,8}$. A more complete understanding of $L_{EX,8}$ is needed when the worker's daily noise exposure is not continuous. CSA Z107.56 provides a calculation methodology when exposure situations are not continuous.

Table 2
Equivalent noise exposure levels resulting in $L_{EX,8} = 85$ dBA
 (See Clause 5.11.)

Duration in a 24-h period	Noise levels (dBA)
24 h	80
16 h	82
12 h	83
10 h	84
8 h	85
4 h	88
2 h	91
1 h	94
30 min	97
15 min	100
7 min 30 s	103
3 min 45 s	106

6 Controlling noise exposure



6.1 General

Once the hazard has been identified and quantified, noise control strategies need to be defined and implemented. Controlling noise exposure comprises engineering controls, administrative controls, and hearing protection devices. This hierarchy of controls is paramount; hearing protection should be the last option considered for controlling noise. In practice, most hearing protection devices provide much less protection than their labelling would suggest, because of the ways in which they are worn — or not worn — by users (see Clauses 6.2, 6.3, and 7).

The best practice is to consider the effects of noise at the design stage. Before any new equipment is introduced to the workplace, the resulting noise level should be determined. Retrofitting is more expensive, but it is unavoidable in some instances and in many workplaces. A number of noise reduction strategies shall be considered, including engineering controls that eliminate or reduce the exposure to a worker, administrative controls that limit the worker's exposure to the noise, and personal protective equipment that protects the worker from exposure. A risk assessment enables a selection of strategies for optimal results.

6.2 Engineering controls — Reducing the noise hazard at its source

6.2.1 General

6.2.1.1

Whenever there is equipment or an activity contributing significantly to workers' over-exposure to noise, there are three elements that shall be considered for the control of noise, as follows:

- a) The source of the noise: This is, in most cases, a machine or part of it that is vibrating. An example would be the engine of a car or a textile loom. Whenever there is noise, there is often some kind of

vibration or aerodynamic pulsation (e.g., from a fan) that has to be found and reduced or eliminated, for example by cushioning an impact, by sliding material rather than dropping it, or by replacing an air jet with an air entraining nozzle.

- b) The noise path: This is the path the noise follows to reach workers' ears. Most of the time, noise travels through the air. Controlling the path involves enclosing the vibrating object (the noise source) or partially blocking the path using a noise barrier. Silencers and mufflers reduce sound travelling down ductwork or pipes.
- c) The noise receiver: In most cases, this is the worker. In order to isolate the receiver from the noise, the worker can be located in an insulated control room (booth). For example, the operator of a power generation station (controller) can oversee the generator and see all the operation data on a display inside the control room (booth).

6.2.1.2

Engineering controls should be the first choice for reducing noise exposure (at their source and along their paths of transmission). An evaluation shall be made of their technical and economic feasibility, considering the following:

- a) This Standard requires that noise be controlled whenever practical, and the best time to do this is during the design stage of equipment, machinery, systems, and facilities.
- b) Much can be done to control noise during design of a new or retrofit facility that cannot be done later.
- c) The most efficient place to control noise is at its source. Secondly, the noise can be controlled along its path. If neither of these can be accomplished, noise control needs to be done at the point of reception.
- d) Part of noise control at source is buying quieter equipment. Effort should be made to find and acquire equipment with lower noise emissions.
- e) Engineering the noise out of a facility might require a detailed and professional evaluation done by noise control engineers or consultants. Such advice shall be obtained before any conclusion is made that it is impractical or not feasible to control a particular noise.
- f) As in any design, it is important that one person or group be directly accountable for the work and serves as a point of contact for all noise design and implementation activities. Responsibility for the effectiveness of this work belongs to the administrator, to discharge or delegate and to supervise.

Note: Examples of engineering control methodologies and practices are provided in Annex B.

6.2.2 Design goal

The main design goal for the equivalent continuous sound level $L_{eq,T}$ for a new workplace shall be to ensure that the daily workers' noise exposure is under the limit of an $L_{EX,8}$ of 85 dBA. To achieve an exposure level of less than 85 dBA, the design goal for the facility should be such that nothing brought into the facility or changed in the facility should produce noise greater than 80 dBA at a distance of 1 m or less, or machinery with lower noise emissions should be used.

Whether building new or retrofitting an existing facility, the reduction of the sound pressure level in a work area below the $L_{EX,8}$ of 85 dBA criterion level is best left to noise control engineers or consultants. They will consider

- a) noise emission data, i.e., emission sound pressure and sound power levels (preferably octave band values); and
- b) calculations of the sound power levels (L_W) of the combination of old and new equipment (with quantitative predictions of workplace sound levels).

Whenever an existing facility is upgraded, purchased equipment should be sufficiently quiet that the facility's design remains at or below the 85 dBA $L_{EX,8}$ criterion, operating in the absence of the original equipment. In this way, noise controls can be applied to the original equipment to meet the criterion of an $L_{EX,8}$ of 85 dBA. To achieve this, it is useful to measure existing sound levels. If quiet equipment is purchased whenever the facility is upgraded, sound levels should drop and eventually meet this Standard's requirements, once all the older, noisy equipment has been replaced.

6.2.3 Specifying quiet equipment

CSA Z107.58 sets standards for reporting the noise emissions of equipment. When designing a facility, engineers and builders should design for a certain noise level by buying equipment consistent with the overall noise level objective for the facility.

Purchasers should favour manufacturers who include noise emission details of their products in product specifications, including technical sales literature and instructions for use. This information allows specific noise limits to be stated in tender specifications, and allows purchasers to assess the potential noisiness of competing items before purchase.

As of August 2010, in the *Notice to Stakeholders — Subject: Noise from Machinery Intended for the Workplace*, Health Canada recommends that machinery intended for the workplace be sold, or imported into Canada, with accompanying standardized noise emission declarations in both the technical sales literature and the instructions for use.

CSA Z107.58 provides detailed information on how to specify equipment using internationally recognized noise emission declarations, based on international measurement standards and test codes providing A-weighted sound level information for the equipment. These noise emission declarations detail the output from these machines in two ways: the sound pressure level (L_p) and the sound power level (L_w).

CSA Z107.58 also provides guidance on how to use these specifications to provide for quieter workplaces. For small equipment, based on a workplace noise design goal of 85 dBA $L_{EX,8}$, the purchase specifications for the declared single-number noise emission values should be 80 dBA for the emission sound pressure level, and 90 dBA for the sound power level. This reflects the fact that very few industrial rooms hold only a single piece of equipment, and many rooms are reverberant. Hence, specifying 85 dBA as the emission sound pressure level at the workstation is not adequate to meet an 85 dBA design goal. Some allowance, typically at least 5 dB, shall be made for the other equipment in the room and the effect of reverberation. While this can be calculated given sufficient information, often major equipment has to be purchased before the details of the room or neighbouring equipment is known.

If more detailed predictions of workplace noise are required, the octave band or 1/3-octave band values of the sound power level and emission sound pressure level should also be requested. Most measurements are done with equipment that automatically collects this information, so it is usually available.

Noise specifications for purchases should be established by

- a) setting the objective and specifying where and under what conditions it is to be achieved and tested;
- b) identifying the level required to achieve that specification;
- c) identifying measurement method(s); and
- d) specifying the reporting methods required to present the data.

Bid analysis and final purchase recommendations need to take into account the range of sound levels available (according to their noise emission declarations) in order to ensure the purchase of equipment that satisfies the noise requirements. In cases when the required equipment might not have been rated, it might be necessary to verify equipment sound levels by witnessing noise tests in a lab, in the factory, or in the field during commissioning.

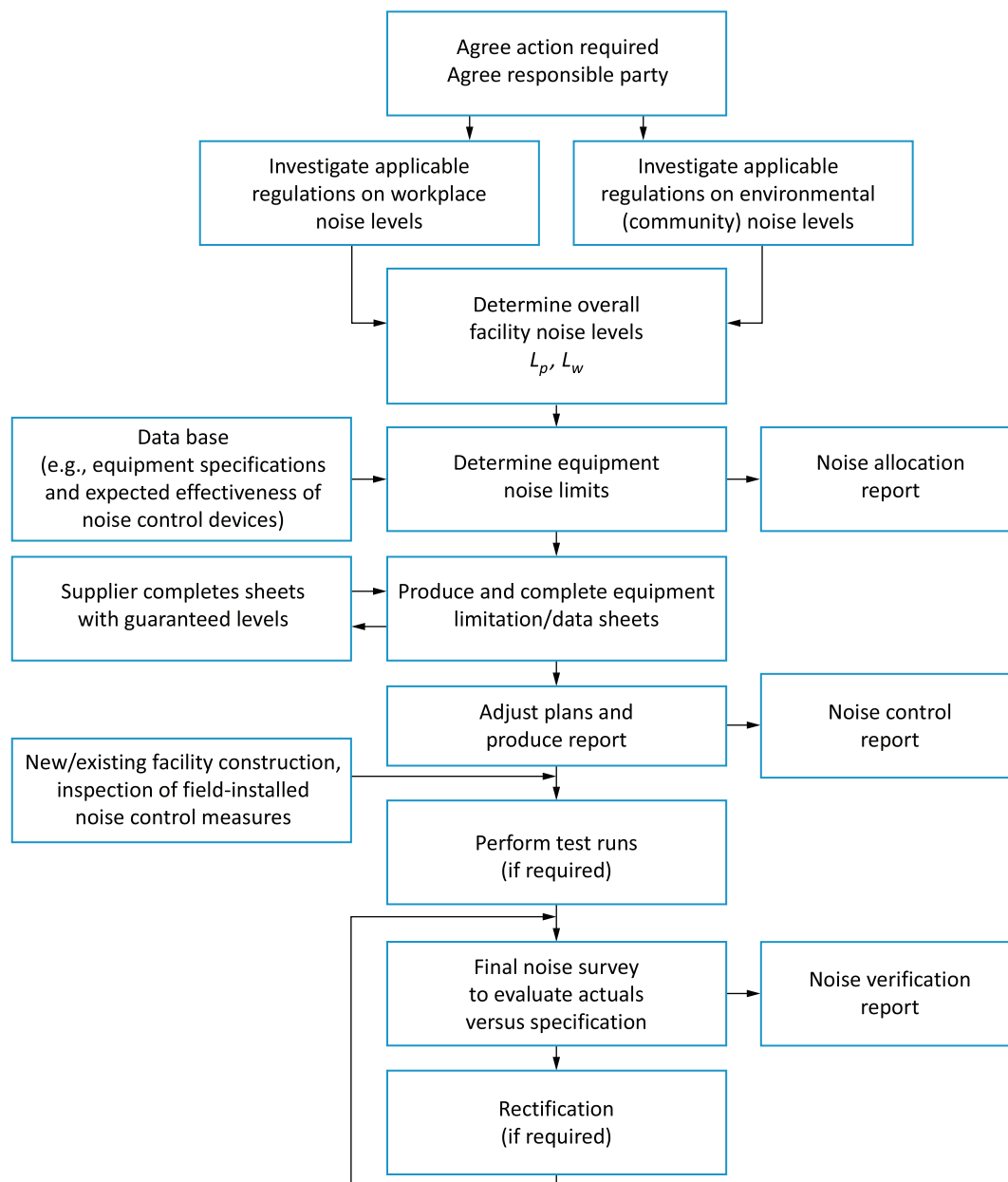
6.2.4 Building quiet facilities

ISO 15664 describes the management of the design process to produce facilities that meet agreed noise requirements. While the ISO Standard is intended for open plants such as refineries, chemical plants, and the like, many of the steps work just as well for enclosed plants, albeit with different prediction schemes. The ISO Standard describes how the end-user, the contractor, and the machinery manufacturer or supplier work together to produce a quiet facility, and describes the workflow to achieve this. Figure 4 of this Standard is a flow chart of the steps required.

An acoustical consultant with experience in the type of facility being designed can guide this process and provide the expertise required to complete the job efficiently and successfully. It is the responsibility of the administrator to ensure these procedures are followed when engineering controls are applied to the facility.

An explanation of the practices in engineering controls can be found in Annex B of this Standard.

Figure 4
Diagram of the process of developing engineering controls
 (See Clause 6.2.4.)



Note: Based on "Noise control flowchart" from Annex A of ISO 15664:2001.

6.3 Administrative controls

When engineering controls have been implemented to their fullest extent and hazardous noise exposure continues to exist, administrative controls shall be used to manage the worker's noise exposure.

Administrative controls include

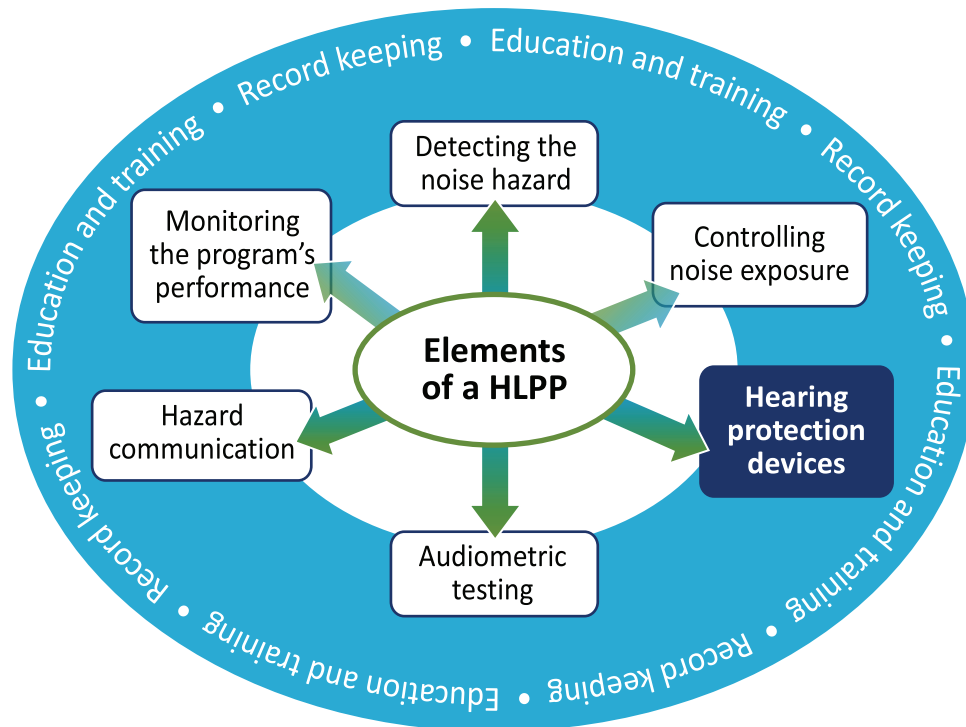
- a) scheduling of work;
- b) job rotation;
- c) limiting the entry of people into areas with excessive noise;
- d) changing the location or surroundings of equipment to limit access; and
- e) observance of quiet work practices.

For example, a noisy machine might operate only on the second or third shift when fewer people are exposed, or a worker might shift to a less noisy job once a hazardous daily noise dose has been reached. For example, once their exposure $L_{EX,8}$ is greater than 85 dBA, the worker has reached 100% of their allowable daily noise dose.

Another administrative control is to provide for quiet areas where workers can gain relief from workplace noise. Areas used for work breaks and lunchrooms should be located away from noise. If it is necessary to locate these areas near the production line, they should be acoustically treated to minimize background noise levels.

Workers would need to spend at least half their time in quiet areas in order to gain as little as 3 dB additional protection. When larger reductions are required, administrative controls can form part of the solution, but are usually not sufficient by themselves.

7 Hearing protection devices (HPDs)



7.1 Overview

Clause 7 covers the last element in the hierarchy of controls for reducing the worker's exposure to hazardous noise. It provides guidance on the selection of hearing protection and addresses how to use various types of hearing protection. It also addresses the issue of attenuation or the protectiveness of various hearing protectors and matching them to the worker's noise exposure.

7.2 Hearing protection strategy

The best way to reduce or eliminate noise exposure is through engineering noise controls, which reduce the noise at the source or along the path, or through administrative controls, which reduce the duration of workers' exposure (see Clause 6).

When these controls fail to reduce noise exposures to acceptable levels, HPDs shall be used. Most HPDs provide less protection, under real-world conditions for worker populations, than their labelled rating would suggest. This is because of the ways in which they are utilized in the workplace. The administrator shall define the requirements of the hearing protection needed, select appropriate hearing protection for those functions, ensure that the selected hearing protection provides sufficient attenuation, and then train workers to get the attenuation that the hearing protection provides.

7.3 Factors to be considered in the selection of hearing protection devices

7.3.1 Factors to be considered

The administrator should consider many factors when selecting hearing protection devices, including the following:

- Which of the workers in the HLPP have normal hearing and which have impaired hearing?

- b) What job functions do those needing hearing protection perform while exposed to noise?
 - i) Is face-to-face communication required?
 - ii) Is radio, telephonic, or electronic communication required?
 - iii) Is there something about the sound field that requires special consideration?
 - iv) Are the HPDs compatible with other personal protective equipment that each worker needs to wear?
- c) Will workers be able to properly fit their protectors?
- d) Are the protectors comfortable enough; will they be worn for the entire shift?
- e) Will the protectors retain their position in or on the ear once fitted?
- f) How easy are the protectors to use?
- g) Do the protectors chosen provide sufficient attenuation (preferably validated through fit testing)?
- h) Are the protectors compatible with communication devices the workers use without removal of the protectors?

Notes:

- 1) See Annex L for assessing hearing protection compatibility with the job (task).
- 2) Hearing conservationists are often challenged by workers who remove or alter their HPDs in order to communicate or better hear their equipment or warning signals. This leads to unprotected exposures. Such exposure might seem minor, but they can rapidly accumulate to result in exposures in excess of a worker's acceptable daily exposure (see Clause 7.6 and Annex G regarding unprotected exposures). It is important to supply HPDs that facilitate communication in noise. However, special care should be taken when using devices to incorporate signals from other sources such as radios (see Clause 7.3.5.4). In any case, unprotected exposures need to be considered when planning an HLLP.

7.3.2 Communication and detection of warning sounds

Being in touch with their environment can provide workers with a sense of safety. The human self-preservation mechanism relies on hearing as the primary self-protection mechanism. Removing auditory contact with warning sounds and interpersonal communication causes some workers enough concern that they might disable some or all of the attenuation of their hearing protection so they feel safe. HPD attenuation should be selected in accordance with the noise exposure and target exposure limit (see Clauses 7.10, 7.11, and 7.12 on matching attenuation to noise exposure).

7.3.3 Considering comfort for work environment and activities

For an HPD to be worn over lengthy periods of time, it needs to be comfortable. Workers shall be directed to first select an HPD that they can wear comfortably for their entire work shift. The HPD also needs to fit securely to be effective, and thus care shall be taken to ensure that a comfortable, secure fit of the HPD is maintained.

Although the degree and nature of sound reduction, or “attenuation”, provided is an important consideration in choosing a particular type of HPD, the best hearing protection is one that is worn and used correctly and consistently. For this reason, HPDs should be selected that are comfortable for wearers in the particular work environment and considering the nature of the work activities.

7.3.4 General hearing protection

7.3.4.1 General

Clause 7.3.4 details HPDs used by most workers who require protection from noise. For the administrators concerned about hearing protection for workers with some existing hearing loss, see Clause 7.3.5. The protectors that fall into this category include earplugs and earmuffs (as detailed in Clauses 7.3.4.2 and 7.3.4.3, respectively).

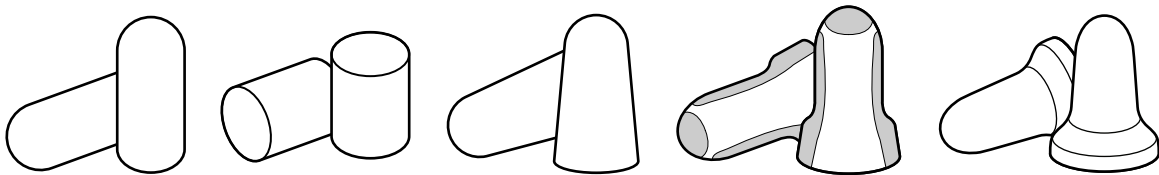
7.3.4.2 Earplugs

Various types of noise-attenuating earplugs exist, as described in Items a) to f). Care should be taken in selecting these earplugs so that the attenuation the worker achieves is consistent with their exposure. See Clause 7.10 for the procedure for adjusting attenuation to account for what takes place in the real world.

Note: Berger (1993) identified a difference between the rated and labelled NRR of a hearing protector and its real world effectiveness. As a result, NIOSH and OSHA in the United States developed formulae to adjust the NRR for a “real world” effect. This Standard incorporates the principles of that work in using NRR, class designation, and SNR (SF_{84}) for hearing protectors.

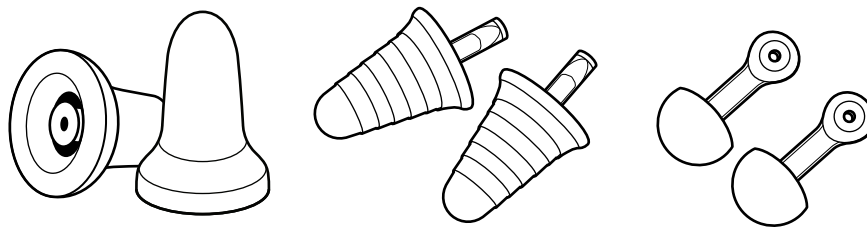
- a) Foam — These earplugs, also called “rolldown” foam earplugs to emphasize the fact that such products need to be rolled and tightly compressed prior to insertion, are made from slow-recovery material. They are often referred to as “disposable plugs”, but most brands can usually be reused a few times. They are sold both as one-size-fits-most and in a range of sizes to fit most ears. In either case, they should be individually sized for the worker’s ear (see Figures 13 and 14). Examples of foam earplugs are shown in Figure 5.

Figure 5
Foam earplugs
[See Clause 7.3.4.2 a).]



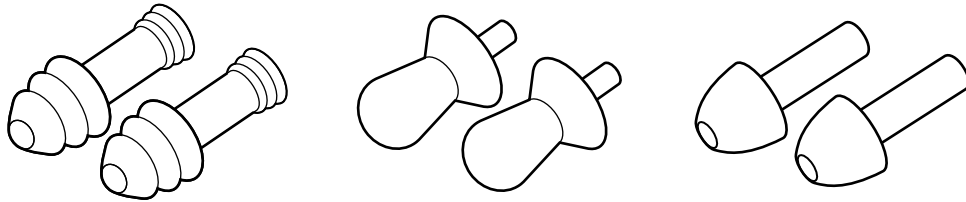
- b) Push-to-fit — These earplugs are composed of similar foams to those used in rolldown foam earplugs, and they consist of a pod, dome, or conical shroud with a flexible stem. Examples of push-to-fit earplugs are shown in Figure 6.

Figure 6
Push-to-fit earplugs
[See Clause 7.3.4.2 b).]



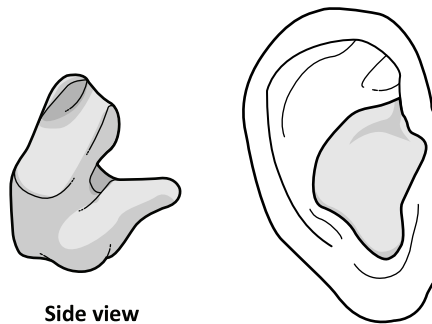
- c) Premoulded — These earplugs, also known as reusable earplugs, are formed from flexible materials into conical, bulbous, or other shapes, often with one or more flanges or sealing rings, which are typically affixed to or enshroud a flexible stem for handling and insertion (see Figure 7). They are sold both as one-size-fits-most and in a range of sizes to fit most ears. Whether available in various sizes or one size, they should be individually sized for the worker’s ear. Some premoulded hearing protectors have a device that can modify the attenuation of the protector.

Figure 7
Pre-molded earplugs
 [See Clause 7.3.4.2 c).]



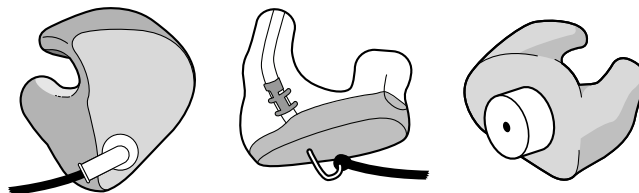
- d) Custom-moulded — These earplugs are fabricated to fit each particular ear. They are most often manufactured from silicone, vinyl, or acrylic materials. The process starts with an impression made with a viscous material that is injected into the ear and ear canal and cures in about 5 min. Depending on the type of custom-moulded protector being made, the process varies. Custom-moulded earplugs are divided into two sub-categories, depending on how they are produced, as follows:
- i) Moulded-in-place — For this type of earplug, the impression itself becomes the HPD. A putty-like material is pressed into the ear and hardens to become the final product (see Figure 8). The impression is removed from the ear, trimmed, coated, and given to the end user. Should a new protector be needed, the process is repeated.

Figure 8
Moulded-in-place custom earplug
 [See Clause 7.3.4.2 d) i).]



- ii) Laboratory-manufactured — For this type of earplug, the impression is sent to a laboratory where it is inspected, deemed suitable, and used to manufacture the actual “lab-made” hearing protector. Should the end user need another protector, many laboratories can make one from the previously taken impression or impression-scan data. Alternatively, the process can be repeated.

Figure 9
Laboratory-manufactured custom-moulded earplugs
 [See Clause 7.3.4.2 d) ii).]

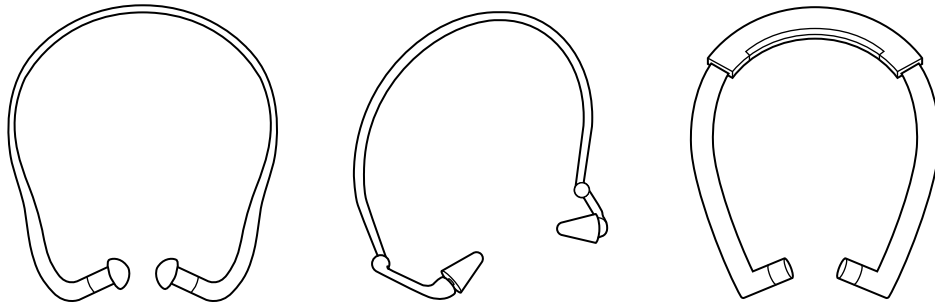


Note: There are three types: solid, vented with an internal filter, and vented with an external filter.

Some laboratory-manufactured custom-moulded earplugs have filters, dampers, or cartridges inserted into a vent or port in the device, allowing the manufacturer to set or reset the attenuation (see Figure 9). Also, these earplugs can be adapted to accept incoming audio from radios (see Clause 7.3.5.4).

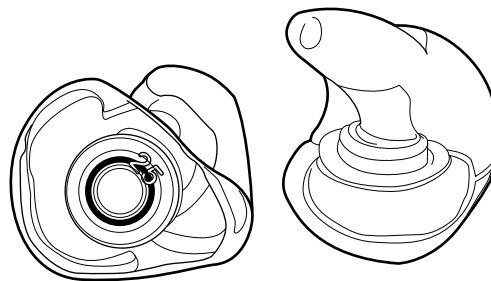
- e) Semi-insert — These earplugs are also known as semi-aural devices, canal caps, concha-seated earplugs, or banded earplugs. They use a lightweight, spring-loaded band to hold soft pods or tips in place (see Figure 10). They can seal in the ear canal or at its entrance, and are best suited to situations where the HPD is frequently removed and then replaced.

Figure 10
Semi-insert earplugs
[See Clause 7.3.4.2 e).]



- f) Adjustable (or user-selectable) attenuation — These are passive earplugs that have wearer-selectable and changeable filters that vary the attenuation of the protector (see Figure 11). Most often, musicians use these protectors as they typically have flat attenuation curves. Because these filters are delicate, these protectors are unsuited to industrial environments.

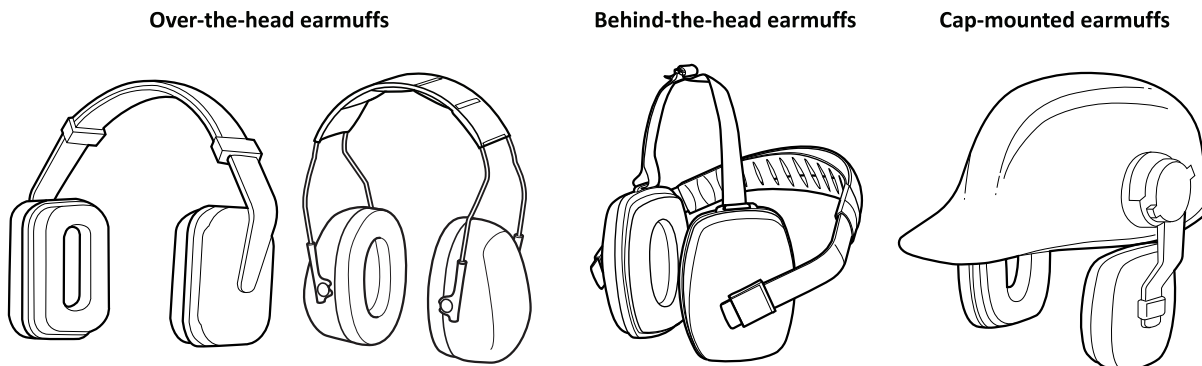
Figure 11
Musician's custom-fit hearing protector
[See Clause 7.3.4.2 f).]



7.3.4.3 Earmuffs

Earmuffs normally consist of rigid moulded plastic ear cups that seal around the ear using cushions filled with foam, fluid, or gel, or cushions combining a fluid-filled bladder with a layer of foam. They are held in place with metal or plastic spring-loaded headbands. The cups are lined with acoustical material to absorb noise within the ear cup. They can be worn over the top of the head, behind the head, or mounted on a hard hat (see Figure 12). Earmuffs can be worn in combination with other personal protective equipment. Some have a device that can modify the attenuation of the protector.

Figure 12
Earmuffs showing various mounting options
(See Clause 7.3.4.3.)



7.3.5 Specialized hearing protection

7.3.5.1 General

The hearing protection job compatibility analysis can identify areas in which some workers might benefit from the use of specialized hearing protection (i.e., having needs that go beyond basic general protection from noise). For example, the need to communicate while in noise, either interpersonally or by radio, places additional requirements on the selection of hearing protectors designed for these purposes.

7.3.5.2 Hearing protectors designed for specific environments

7.3.5.2.1 Flat attenuation hearing protectors

Flat attenuation HPDs incorporate a sound channel (vent) and resonator or a diaphragm located in the channel that provides near-flat attenuation between frequencies of about 200 and 4000 Hz. This attenuated sound is perceived as more natural, without the muffling effect of the reduced high frequencies typical of the conventional HPD. These devices are often used by individuals with normal hearing or a mild hearing loss who have a critical need to hear certain sounds clearly (e.g., speech, music, or other communications) while being protected against hazardous noise. Some flat attenuation protectors, also called musician's protectors, are susceptible to moisture and dirty environments. Care shall be taken to ensure that the protectors selected are able to meet the characteristics of the workplace (e.g., work environment and work demands).

7.3.5.2.2 Active noise reduction (ANR) devices

ANR devices can be useful in fixed-noise environments with predominately low-frequency noise. ANR HPDs, both earmuff and earplug types, use the destructive interference properties of out-of-phase sound waves to reduce the ambient noise at the ear. ANR effectiveness is limited to low frequencies, typically below 500 to 800 Hz for earmuffs or 800 to 1200 Hz for earplugs for broadband noise, where 5 to 15 dB of additional attenuation can sometimes be achieved over the passive attenuation of the device. ANR systems can be useful in increasing the intelligibility of speech in areas of high-level, low-frequency noise, such as in helicopters, propeller-driven aircraft, and tracked or wheeled vehicles, and are often built into communication headsets in these applications.

7.3.5.2.3 Amplitude-sensitive or level-dependent protectors (passive)

These devices are primarily used to protect against the effects of impulse noise. They provide low attenuation at low noise levels and increase protection as the noise level rises, but the level-dependent change does not begin until about 110 to 120 dB L_p . The devices commonly have an orifice with an element in it that provides the level-dependent operation. When the device is an earplug, extra care should be taken in fitting this kind of device, as the user might not be able to distinguish between sound passing through the open channel (as intended) and sound leaking around the periphery. Because the attenuation of these devices changes with level (almost always increasing as level increases), the attenuation-at-threshold values provided by this Standard do not apply, except at low noise level, and will typically underestimate the actual attenuation.

7.3.5.2.4 Sound-restoration (or active level-dependent) hearing protection devices

Sound-restoration (or active level-dependent) HPDs are electronic devices designed to improve speech intelligibility and auditory perception in situations where high noise levels alternate with quiet periods. A microphone captures the sound outside the protector, which is then reproduced by a speaker inside the ear cup or earplug. The amplification is such that in quiet surroundings, the sound is perceived almost at the same level inside as outside the protector; that is, as if no protection were worn. Several devices even boost external sounds by 15 dB or more in very quiet periods, which can benefit users with pre-existing hearing loss. This controlled amplification is designed to limit noise to non-hazardous levels. As the noise level outside increases, the amplification decreases, and is eventually shut off. At that point, the protector acts as a conventional passive HPD.

7.3.5.3 Hearing protection with enhanced interpersonal communication

7.3.5.3.1 General

One of the deficiencies of HLPPs is the ineffectiveness of hearing protection owing to workers removing it or adjusting it to facilitate communication. HPDs that enable or enhance interpersonal communication can stop this tendency in workers.

7.3.5.3.2 Frequency-sensitive protectors — Passive

These devices are intended to improve communication by allowing sound in a predetermined range of frequencies to pass through the device, while stopping other frequencies. This is normally done by means of an aperture, channel, or vent in the device fitted with a frequency-specific filter. The resulting HPD improves face-to-face communication while maintaining protection at slightly reduced attenuation.

Note: *Hearing protection, unlike other PPE, can disable the sense it is designed to protect. Trying to enable that sense can expose the worker to unprotected exposures (see Clause 7.6 and Annex G).*

7.3.5.4 Hearing protection for use in combination with radio communication

7.3.5.4.1 General

As with other forms of interpersonal communication, using radio communication (e.g., 2-way radio, cellphone, or FM radio) might cause those wearing hearing protection to remove or disable their protection to facilitate conversation. To prevent this, workers should have their incoming audio integrated with their hearing protection. This would allow them to conduct a conversation without removing their hearing protection. There are several types of hearing protection that will do this.

7.3.5.4.2 Noise-attenuating communication headsets — Electronic

A communication headset is a device (i.e., earplug or earmuff) designed primarily for voice transmission from/to a remote location. In wired systems, this is achieved through the use of cables connected to external radios or audio consoles. In wireless systems, one of several technologies (e.g., two-way radio, FM, or Bluetooth) can be used and the associated circuitry is built into the device. Communication headsets can include passive and/or active means of protection against external noise. Headset amplifiers should also include automatic volume control (AVC) and peak-limiting circuitry to control the output level when momentary increases in signal and/or noise levels occur.

The sound exposure experienced by the headset user is the combination of the external noise passing through the device and the speech emitted through the enclosed earphones. The communication system volume control should be set to a level adequate for effective communication but not so loud that the speech and/or noise signals themselves result in hazardous exposures.

Note: CSA Z107.56 provides measurement methods to assess total exposure with communication headsets.

These headsets can be in the form of earplugs or earmuffs. As well, sophisticated communication headsets (either earplugs and earmuffs) with electronic circuitry and software designed for speech enhancement and noise suppression exist. Using these devices when connecting to radios can vastly improve the worker's experience using hearing protection and a radio in noise.

7.3.5.4.3 Earplugs with radio communication attachments

Earplugs with the ability to connect to the incoming audio of various radio communication devices eliminate the need to remove the earplugs for radio communication. These earplugs typically have a channel or vent through the plug with a filter positioned to attenuate the earplug. The radio device's incoming audio is redirected from a speaker microphone or radio to the earplugs through a cable, speaker, or transducer, and a sound tube that connects to the earplugs. The incoming audio then reaches the worker's ear in the same manner as face-to-face communication without having to remove the earplugs.

7.3.5.5 Hearing protection devices with direct music (active)

These hearing protectors are designed to connect to personal listening devices such as MP3 players and radios. They are used because allowing the worker to play their music through these devices can increase worker productivity and focus on their jobs. The sound exposure experienced by the user is the combination of the external noise passing through the device and the music emitted by the earphones themselves. Music sound levels might be set higher than safe levels, and care should be taken to control the listening duration or music volume to limit exposure. The administrator shall only permit devices that incorporate built-in noise limiters to control the levels to which the music can be played to be used.

Earphones associated with recreational use, such as those supplied with personal listening devices, shall not be considered HPDs nor shall they be used in conjunction with HPDs. In many cases, these devices can actually increase an individual's noise exposure in noisy environments (as the user increases the volume to compensate for interference from insufficiently attenuated ambient noise). Therefore, they shall not be used as hearing protectors.

7.3.5.6 Noise exposure from voice, music, or other signals in headsets, earplugs, or HPDs

The noise exposure experienced by the user of headsets, earbuds, and HPDs with an internal speaker for speech, music, or other sounds is the combination of the external noise passing through the device and the sound emitted through the enclosed speaker. The communication system volume control

should be set to a level adequate for effective communication, but not so loud that the speech and/or noise signals themselves result in hazardous exposures.

In many cases, such signals can seriously degrade protection or even increase the noise exposure of individuals wearing them, even in areas with sound levels as low as 70 dBA. Before such devices are issued, the total noise exposure from both sources shall be estimated using the procedures in CSA Z107.56.

Caution: *Listening to music or talk radio can interfere with the proper reception of important sounds from the surrounding work environment. Use of such systems should be carefully considered and limited to environments in which there is no critical need to readily and quickly perceive key sounds or warning signals.*

7.4 Use and fitting of HPDs

7.4.1 General

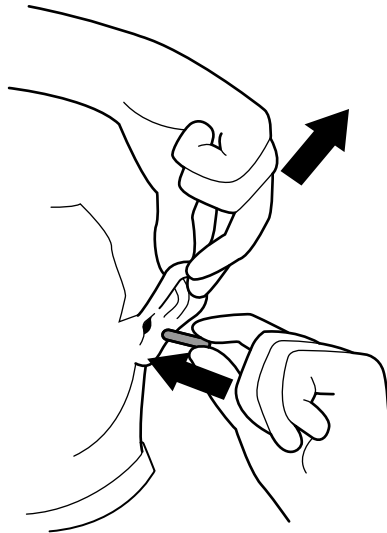
Once the workers have selected their HPDs, it is critical that they learn the correct methods for using and fitting their HPD to obtain the maximum benefit. Each HPD has its own fitting technique that shall be taught to the worker as summarized in Clauses 7.4.2 to 7.4.10. Manufacturers should provide instructions with details specific to each HPD (see also Clause 11 of CSA Z94.2).

Note: *The directions in Clauses 7.4.2 to 7.4.10 apply to both passive and active earplugs and earmuffs as fitting and insertion methods for passive and active devices are the same.*

7.4.2 Use and fitting of earplugs

Before considering any initial fitting of an earplug, an otoscopic examination of the ear should be performed. The otoscope inspection can also aid in identifying the best HPD based on anatomical features. Any issues, such as cerumen (wax) partially or completely blocking the ear canal, drainage, infection, or if the worker complains of pain in the ear, are conditions for referral to a hearing health care professional for examination and possible treatment before inserting an HPD into the worker's ear canal.

Figure 13
Correct earplug fitting technique
[See Clauses 7.3.4.2 a), 7.4.2–7.4.5, and 7.4.8.]



Note: *Drawing adapted from AIHA's The Noise Manual, Figure 10.8, page 403.*

Individuals qualified in otoscopic inspection should inspect the person's ear canal to identify any anatomical factors that might interfere with the use of an earplug or to determine any possible health issues or medical conditions. If any health issues or medical conditions are present, earplugs should not be worn until a physician or audiologist has indicated otherwise.

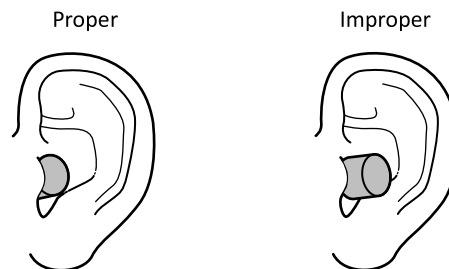
Regardless of the type of earplug, the worker's hands and the hearing protector should be clean prior to use. When fitting most earplugs, it is best to open and straighten the ear canal during insertion. This is accomplished by reaching the opposite hand over the head and pulling the pinnae of the ear outward and upward (see Figure 13).

When earplugs are available in different sizes, the selected earplug should be reasonably comfortable, but fit snugly. The earplug should not come out the ear easily. If it does, it should be removed and the fitting repeated. If the HPD still does not fit, another type of earplug shall be selected. Earplugs should be removed with a twisting motion to avoid suction.

7.4.3 Insertion of foam earplugs

To insert a foam earplug, it is first slowly rolled and compressed between the thumb and forefingers into a very thin cylinder without creases. The compressed earplug is then inserted well into the ear canal while pulling the pinnae of the ear outward and upward with the opposite hand as shown in Figure 13. The earplug should be touched to check the fit after it expands. Only the end of the earplug should be felt; otherwise, the earplug should be removed and the rolling and compressing repeated to refit it (see Figures 13 and 14).

Figure 14
Proper and improper insertion of a foam earplug
[See Clauses 7.3.4.2 a) and 7.4.3.]



Note: Drawing adapted from AIHA's The Noise Manual, Figure 10.11, page 406.

7.4.4 Insertion of push-to-fit earplugs

To fit a push-to-fit earplug, the foam tip is inserted into the ear canal while the pinnae is pulled outward and upward with the opposite hand (see Figure 13). If present, twisting the stem while inserting can be helpful for best fit. Pulling the plug stem of the earplug gently checks the fit. The earplug should not come out of the ear easily. If it does, the earplug should be removed and the fitting repeated. For models without a stem, if the finger touches the ear as well as the earplug, it is probably inserted deeply enough to be effective. To remove the push-to-fit earplug, simply grasp the earplug and rock or twist it out of position slowly.

7.4.5 Insertion of premoulded earplugs

To fit a premoulded earplug the rounded tip is inserted into the ear canal while the pinna is pulled outward and upward with the opposite hand (see Figure 13). The earplug is adjusted for best noise reduction. Pulling the earplug stem gently checks the fit. The earplug should not come out of the ear

easily. If it does, that earplug should be removed and the fitting repeated with a larger size plug. To remove a premoulded earplug, grasp the earplug and rock or twist it out of position slowly.

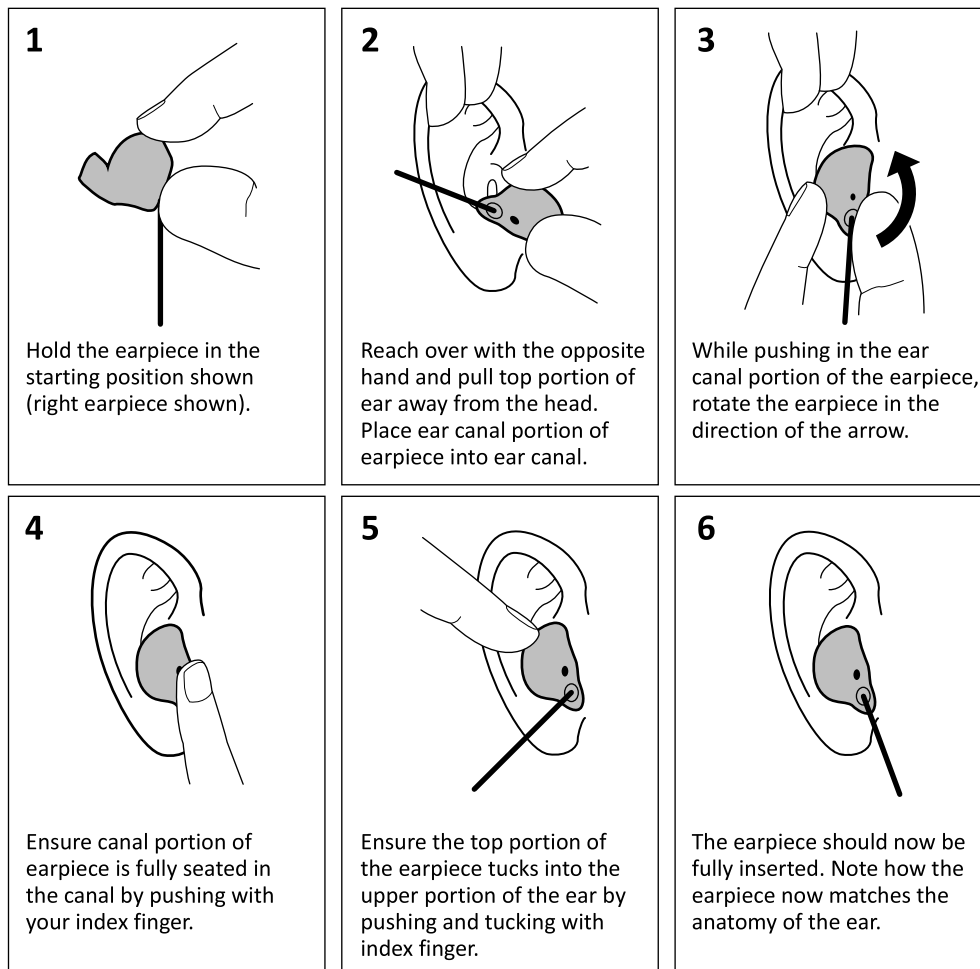
7.4.6 Insertion of formable earplugs

Fitting formable earplugs of the style that are not encased in a bladder, involves moulding the material into a spherical shape and pressing it into outer ear and the ear canal entrance until a tight seal is made. Formable earplugs are typically found in consumer and recreational setting and are not commonly used in occupational HLPPs.

7.4.7 Insertion and removal of custom-moulded earplugs

Custom-moulded earplugs are inserted by gripping the outer portion of the earplug with the thumb and forefinger (if a tab is present on the outside of the earplug, it is to be gripped) and the tip of the hearing protector is inserted into the ear canal (see Figure 15, panel 2). The earplug is rotated towards the back of the head as it slides into the ear canal, until a snug seal is obtained (see Figure 15, panel 3). The rotation is continued past the pocket at the top of the ear and then the top of the protector is inserted into the pocket, counter-rotating it forward to seat it in the pocket. As with other earplugs, pulling the pinnae can ease the insertion process (see Figure 15, panel 2). To remove custom-moulded hearing protectors, the seal is broken by pushing up on the back ear and then the protector is rotated forward before sliding it out of the ear. Custom-moulded earplugs should never be pulled directly from the ear as a small vacuum might be created that can damage the eardrum (tympanic membrane) and middle ear.

Figure 15
Insertion of custom-moulded earplugs
 (See Clause 7.4.7.)



7.4.8 Insertion of semi-insert earplugs

Semi-insert earplugs are inserted by placing the band in the indicated position, holding the pod or protector, and directing it into the ear canal opening. The earplug is firmly pushed and wiggled into the canal until it forms a snug seal. If the semi-insert has a foam tip, it is not necessary to roll and compress the foam first. Care should be taken to ensure that the band is not over stretched, as it will reduce the tension on the earplug. Some people might need to open the ear canal by pulling the ear outward and upward with the opposite hand while inserting the tip of the earplug (see Figure 13).

Semi-insert HPD headbands may be worn under the chin, over the head, or behind the neck, as specified by the manufacturer's use and fitting instructions.

7.4.9 Use and fitting of earmuffs

In order to ensure earmuffs provide the noise attenuation for which they are designed, they are required to fully enclose the ears and seal against the head. Therefore, earmuffs need to fit around the ears and conform to the head shape of the wearer. The importance of this fitting cannot be understated. The following checks shall be performed:

- a) Ear cups shall press tightly against the head.

- b) Head coverings, stocking caps, hoods, or other clothing coming between the ear cup and the head will disrupt the seal. The wearing of a head covering that covers the ears under the earmuff cushions, such as a balaclava, will degrade attenuation, and therefore should be avoided.
- c) Long hair, pencils, ear buds from personal audio devices, hat cap bands, and jewellery should be removed or kept out of the way.
- d) Safety eyewear temples should be as thin as possible, and as close to the head as possible, to reduce their negative effect on the attenuation of the earmuff.

All of these checks improve the seal of the cups against the head. In cases where it is not possible to get a tight fit of the HPD, alternative HPDs should be considered. Figures C.1 and C.2 display the attenuation for an earmuff with a compromised seal. Earmuffs with a poor seal, e.g., caused by thick safety glasses temples (see Figure C.1) or by a hairnet (see Figure C.2), have much-reduced attenuation. Earmuffs with a good seal provide attenuation at all frequencies.

7.4.10 Use and fitting of helmets

Fitting these devices is particular to the specific model and often includes a degree of adjustment or customization of the helmet to the head. The manufacturer's instructions should be followed closely.

7.4.11 Field attenuation estimation systems (FAES) — Fit testing systems

Field attenuation estimation systems (FAES) are intended to estimate the attenuation of hearing protection devices that individuals receive in practice. FAES differ from other attenuation estimation methods because they yield a personal attenuation rating (PAR) obtained for each worker, rather than a noise reduction rating based on a group of individuals as measured in a laboratory environment. The PAR reported by FAES can be subtracted directly from the worker's noise exposure or sound level, measured in dBA, to determine the protected exposure or sound level under the HPD. Although the various fit testing systems have the same purpose and produce attenuation values that are presented in similar ways, the technologies used to produce the PARs differ, and the results are not necessarily comparable between FAES. Most commercially available systems focus on testing earplugs, as earmuffs tend to be simpler for workers to fit and show less variable attenuation than earplugs.

Fit testing data are based on measurements at a single point in time, and provide a more direct estimate of the protection that a given individual is expected to receive from their HPD than does average data from a group of subjects in a separate laboratory experiment. However, fit testing data are still not based on in-situ measurements for actual users and the exposures they experience during a work shift. Thus, fit testing data reflects what a user can achieve and has been shown to achieve, not necessarily what the user actually achieves day-to-day.

FAES can be used to help workers and/or employers to

- a) select the HPD most appropriate for the noise exposure based on an individual attenuation estimate;
- b) select the HPD that best fits the individual ear canal;
- c) learn fitting techniques and develop skills to properly insert the HPD consistently;
- d) teach trainers to properly counsel workers on HPD selection and fit;
- e) verify and compare the performance of the HPD to a previous measurement; and
- f) identify at-risk workers who have a mismatch between HPD attenuation and workplace noise exposure, either due to insufficient or excessive attenuation.

7.5 Overprotection

Overprotection can have as serious consequences as under-protection. While under-protection leaves the HPD user at risk of NIHL, overprotection can create a safety risk. This is particularly true for jobs that require auditory awareness of equipment sounds and warning signals, and communication with other workers or supervisors. Overprotection produces a sense of isolation, particularly for hearing-impaired workers. When an HPD is selected solely for the highest attenuation, there is a potential for overprotection. Table 3 provides guidance for selecting the appropriate amount of noise reduction provided by HPDs.

Table 3
Recommendations for matching HPD attenuation to noise exposure
 (See Clauses 7.5 and 7.12.2.1.)

Sound level at the ear resulting from the use of the protector, dBA	Protection outcome
85+	Insufficient
80–85	Acceptable
75–80	Optimal or ideal
70–75	Acceptable
Less than 70	Potential overprotection (see Clause 7.5)

7.6 Effect of temporary removal of an HPD while exposed to noise

When an HPD is removed (even temporarily) while the user is exposed to hazardous noise, its effective protection over the entire day is reduced.

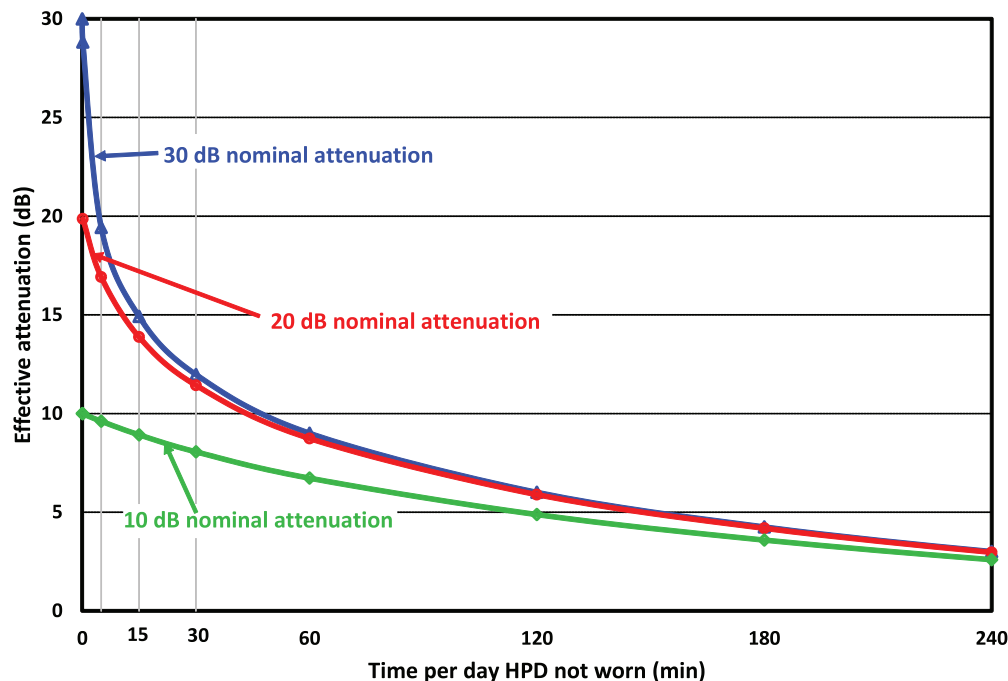
For a higher-rated HPD, there will be a greater reduction in effectiveness when the HPD is removed for even short periods.

Figure 16 shows the effective attenuation as a function of the time (in minutes) that a protector is not worn. Three protectors are shown, with nominal attenuations of 10, 20, or 30 dB. The nominal attenuation is the protection provided if always worn, and the effective attenuation is the protection provided if the protector is not worn for the period of time shown in a day. It can be seen that removing the 30 dB protector for as little as 5 min a day reduces the overall protection of the 30 dB protector to only 20 dB.

If either the 30 dB or 20 dB protector is taken off for 1 h (60 min), the effective daily attenuation drops to 8 dB. If it is taken off for 2 h (120 min), the attenuation drops to only 6 dB.

Note: Removing an HPD for 5 min at a time, six times per day, has the same effect as removing it once for 30 min.

Figure 16
Effect of removing a hearing protector (unprotected exposure) on attenuation
 (See Clause 7.6.)



7.7 Communication in noise

7.7.1 General

A common reason for removing an HPD is the need to communicate. Alternatives exist that provide for and even enhance communication while still providing protection.

7.7.2 Interpersonal communication

Interpersonal communication improvement can be facilitated by choosing the correct type of hearing protection device. Both earmuffs and earplugs that are interpersonal speech enabled should be considered. Earmuffs with pass-through circuits and earplugs with filters designed to enhance speech are available (see Clause 7.3.5.3).

7.7.3 Radio communication

Use of radio communication in noise can cause a situation where the worker is removing their HPD to use their radio. When workers are unable to use their radios without removing their HPDs, their radio's incoming audio should be incorporated into the HPDs. Consideration shall be taken to ensure that the combined dose of the protected noise and signal from their radios does not exceed 100%. A description of devices that allow the incoming audio from 2-way radios, cellphones, and IDEN phones and incorporate hearing protection is found in Clause 7.3.5.4.

Caution: *Listening to music or talk radio can interfere with the proper reception of important sounds from the surrounding work environment. Use of such systems should be carefully considered and limited to environments in which there is no critical need to readily and quickly perceive key sounds or warning signals.*

7.8 Cleaning and maintenance of hearing protection devices (passive and specialized devices)

7.8.1 General

Hearing protection devices should be inspected, cleaned, and maintained according to the manufacturer's instructions. Each hearing protection device shall be maintained, and its parts or components replaced, as required to retain its original effectiveness.

The life expectancy of an HPD depends on wear time, working conditions, and environmental factors. Hearing protection devices and their components can become damaged over time with prolonged use of sanitizing or disinfecting products, including pre-moistened sanitizing towelettes. Regular inspection of the workers' HPDs is essential to ensure optimal performance.

7.8.2 Cleaning and maintenance of earplugs

Dirt and debris should be wiped from earplugs with a dry, clean cloth. Earplugs should be replaced when they become contaminated, change noticeably in firmness, or do not expand to their original size and shape after use.

Additionally, for electronic earplugs, if the earplug is composed of a reusable material, it should be washed according to the manufacturer's instructions. If the earplug portion is composed of foam, debris should be wiped off with a dry, clean cloth. The earplugs should be replaced as needed and should not be immersed into water or any solution. To protect electronic earplugs from damage, they should be turned off manually before batteries are replaced.

Custom-fit earplugs should be washed with warm water and mild soap as needed. Care should be taken with vented earplugs (with a bore through the plug) not to use blown air to clear the bore as it can dislodge components. Some manufacturers advise minimal cleaning, only as necessary, as the cerumen (wax) on the protector is a natural and bio-compatible antibiotic.

7.8.3 Cleaning and maintenance of earmuffs

7.8.3.1

Earmuffs should be inspected daily before use by those wearing them. The administrator shall ensure that the technique for inspecting earmuffs is known by those wearing them. The inspection involves

- a) checking the earmuff cushion for and leaks or cracks; and
- b) ensuring that the headband force-holds the earmuff snugly against the sides of the head.

7.8.3.2

If either of the two inspections described in Clause [7.8.3.1](#) shows that the earmuff is worn out and not functioning "as new", it should be replaced. As well, wearers of earmuffs should

- a) regularly inspect earmuffs for cracked or worn parts, and replaced as necessary; and
- b) replace the cushions at least every six months. If the earmuff does not have replaceable cushions, the wearer should replace the entire earmuff.

Earmuffs should not be immersed into water or any solution. The headband should not be bent, reshaped, or overstretched. Earmuffs should be stored in temperatures less than 55 °C.

Additionally, to protect electronic headsets from damage, they should be turned off manually before batteries are replaced. Removable microphone windsocks shall be inspected regularly and replaced as necessary.

Note: Headband force on an earmuff is important for the overall effectiveness of an earmuff. Regardless of the headband placement (e.g., over the head, cap mounted, etc.), the headband force decreases over time from regular use or by deliberate modifications by the wearer. For over the head models, band force can be roughly checked by comparing the resting position of a new earmuff to a used earmuff. When comparing the two earmuffs, the cup-to-cup separation should be approximately the same. In daily use, earmuff cushions should be replaced at least every six months.

7.9 Provision of hearing protection

7.9.1 General

The organization shall provide hearing protection for all workers whose $L_{EX,8}$ is greater than 85 dB after other measures have been implemented (see Clauses 6.2 and 6.3 on engineering controls and administrative controls). The hearing protection shall be selected in accordance with Clause 7.12. Training in its use and education as to its effectiveness shall be done in accordance with Clause 10.

The worker's need for hearing protection shall be evaluated individually, based on job function, hearing, other personal protective equipment worn, and any specific worker requirements. Once completed, the hearing protection job compatibility analysis (see Annex L) will yield a range of hearing protector types that might be used within the facility. The administrator shall offer a selection of types of protectors that all meet the requirements of the hearing protection job compatibility analysis so that the workers can choose protection they can comfortably wear throughout their shift.

7.9.2 Selection of hearing protection devices

Once the hearing protection job compatibility analysis has been completed, hearing protectors shall be considered for use based on

- a) their compatibility with the analysis;
- b) their comfort for the wearer; and
- c) the attenuation they provide given the wearer's noise exposure.

The findings of the hearing protection job compatibility analysis shall be recorded in the worker's records relating to the worker's participation in the HLPP.

7.9.3 Use of hearing protection devices

The administrator shall verify that workers are not modifying their HPDs. The administrator shall regard these modifications as a symptom of a problem with the fitting or selection of the protector, and work with the worker to understand the problem, educate them about possible solutions, and select a protector that mitigates their concerns. Through inspection, education, and training, the administrator shall ensure that workers do not need to modify their HPDs.

7.10 Using attenuation data and derating to select HPDs

7.10.1 General

In selecting the proper hearing protector, an important criterion is the amount of protection — or “attenuation” — the protector gives the wearer. The amount necessary is determined from the worker's exposure and the “target exposure limit” chosen. The attenuation of the chosen protector shall bring the “under-the-protector” exposure below the target exposure limit.

7.10.2 Attenuation

Attenuation is used to estimate the effective sound level for the protected person. As such, it is important in choosing the protector most appropriate for a given noise environment. Attenuation varies with sound frequency. Several single-number ratings have been introduced, each calculated from laboratory test results. Examples include the NRR, currently used in the United States, and SNR(SF₈₄), defined in CSA Z94.2.

7.10.3 Laboratory versus field attenuation

Laboratory measurements, done under ideal conditions, generally show HPD attenuation greater than is achieved in practice. This is chiefly because of less than ideal fit and use of the protector in the real world. If the HPD does not fit the wearer adequately, or has not been adjusted properly on the wearer's ear, or simply does not fit the wearer's ear, attenuation will not approach laboratory measures.

7.10.4 Attenuation measurement methods

There are two standardized methods used in Canada to assess the attenuation of hearing protectors, as follows:

- a) Experimenter-fit real-ear attenuation (per ANSI S3.19) — Experimenter-fit attenuation is measured according to the “real-ear attenuation at threshold” procedure defined in ANSI S3.19. These values indicate the optimum performance of well-fitted hearing protectors under laboratory conditions.

Note: The ANSI S3.19 test method is specified in U.S. EPA 40CFR Part 211, Subpart B.

- b) Inexperienced subject-fit real-ear attenuation (per ANSI/ASA S12.6, Method B) — Inexperienced subject-fit attenuation is measured according to the “real-ear attenuation at threshold” procedure in ANSI/ASA S12.6, Method B. The use of Method B is intended to approximate real-world attenuation that can be expected for occupational users.

7.10.5 Derating hearing protection

7.10.5.1 General

The rating systems used for hearing protection attenuation rating often provide the potential protection the hearing protector can provide. The administrator shall ensure that a derating system consistent with the measure of performance used for the protection is used in all calculations of the under-the-protector exposure for the worker.

7.10.5.2 Derating NRR

It has been widely recognized that the NRR overestimates the attenuation generally achieved under real-world conditions. To account for the discrepancy between the laboratory results and the real-world attenuation, this Standard recommends derating the NRR as shown in Table 4 (in accordance with CSA Z94.2, Table 2).

Table 4
Effective rating calculations for the NRR
 (See Clauses 7.10.5.2, 7.12.3.2, 7.13, and H.2 and Table H.1.)

Device type	Percentage of NRR achieved	For use with dBA	For use with dBC
Earplugs	50%	$L_{eq} - [NRR(0.5) - 3] = XX \text{ dBA}$	$L_{Ceq} - NRR(0.5) = XX \text{ dBA}$
Earmuffs	70%	$L_{eq} - [NRR(0.7) - 3] = XX \text{ dBA}$	$L_{Ceq} - NRR(0.7) = XX \text{ dBA}$
Dual protection	65%	$L_{eq} - [(NRR + 5)(0.65) - 3] = XX \text{ dBA}$	$L_{Ceq} - (NRR + 5)(0.65) = XX \text{ dBA}$

Notes:

- 1) Use of the deratings shown in this Table might be helpful in estimating average protection for groups of users, but the deratings cannot be used to estimate protection for individual users.
- 2) Predicted values should be rounded to integer values.
- 3) The NRR that is used for the dual-protection calculations in row 4, columns 3 and 4, is the higher of the individual NRRs of the two devices.

Example for use with A-weighted sound measurements:

If the user wishes to apply the NRR to an A-weighted sound level, then the NRR shall be reduced by 3 dB after the derating is applied. For a measured A-weighted L_{eq} of 95 dBA and an earmuff with an NRR of 26, the predicted A-weighted effective L_{eq} is computed as follows:

$$95 \text{ dBA} - [26 (0.7) - 3] = 95 - [18.2 - 3] = 79.8 \text{ dBA, which rounds to 80 dBA.}$$

Example for use with C-weighted sound measurements:

For a measured L_{Ceq} of 95 dBC, and using the earmuff from the preceding example with an NRR of 26 dB, the predicted A-weighted effective L_{eq} when the hearing protector is worn is computed as follows:

$$95 \text{ dBC} - 26 (0.7) = 95 - 18.2 = 76.8 \text{ dBA, which rounds to 77 dBA.}$$

Example for use with A-weighted sound measurements and dual protection:

For a measured A-weighted L_{eq} of 105 dBA, and a combination of an earplug with an NRR of 33 dB and an earmuff with an NRR of 26 dB, the calculation proceeds as follows:

$$105 \text{ dBA} - [(33 + 5) (0.65) - 3] = 105 - [24.7 - 3] = 83.3 \text{ dBA, which rounds to 83 dBA.}$$

This computation includes the required 3 dB correction for use with A-weighting as illustrated in the “Example for use with A-weighted sound measurements” above.

Notes:

- 1) “Earplugs” includes the following types (see Clause 7.3.4): rolldown foam, push-to-fit, premoulded, formable, custom-moulded, and semi-insert. “Earmuffs” includes both cups on a head/neck band and cap-attached earmuffs.
- 2) In cases where the attenuation of the combined devices is provided by the manufacturer, the percentage-achieved value in this Table is applied to the reported NRR of the earplug plus earmuff. In cases where the attenuation data of the combined devices are not available, the computation in either column 3 or 4 of this Table is utilized.
- 3) The reason that a 3 dB adjustment is required for use of the NRR with A-weighted sound levels is that the derivation of the NRR was based on measuring sound exposure in dBC in order to estimate the predicted protected level in dBA. The 3 dB adjustment utilized above was selected based on the most current analyses of occupational noise data as found in Gauger and Berger (2004), and in place of the 7 dB adjustment previously specified by the U.S. National Institute for Occupational Safety and Health. The Gauger and Berger work indicates that a more representative and appropriate correction for prediction errors arising using NRR with A- instead of C-weighting is 3 dB instead of 7 dB.

7.11 Assigning hearing protection devices based on attenuation and noise exposure levels

Four methods of assigning hearing protection devices, based on noise levels and attenuation measurement results, are specified in this Standard, as follows:

- a) use of classes, which pre-assigns the HPDs to defined attenuation ranges;
- b) use of a single number, like the NRR or the SNR(SF₈₄);
- c) the octave-band approach (see CSA Z94.2 to understand this method of derating); and
- d) field attenuation estimating system (FAES) fit testing.

For guidance on how to select the appropriate attenuation and/or derating method, see Annex H.

The administrator shall choose one of the above approaches for estimating the attenuation of the protectors used and use that approach to estimate the worker's protected exposure, and then document the results of the choice.

The method of classification using Table 5 will provide sufficient accuracy.

In special situations (e.g., noises with substantial high- or low-frequency content), it might be advantageous to use either the single-number or the octave-band approach. Additionally, use of the octave-band approach is required for an L_{EX,8} greater than 105 dBA. FAES should be used for improved accuracy (see Clause 7.4.11).

The administrator shall use hearing protectors that meet the requirements of CSA Z94.2. SNR(SF₈₄), class designation, and NRR are based on laboratory test reports. A manufacturer claiming product compliance with CSA Z94.2 is required to provide these test reports to the purchaser upon request.

7.12 Methods for selection of hearing protection devices

7.12.1 General

The appropriate hearing protector shall be chosen according to one of the methods specified in Clauses 7.12.2, 7.12.3, and 7.12.4.

7.12.2 Class

7.12.2.1 Using hearing protector class in the HLPP

If the administrator is using class to determine the appropriate hearing protector, hearing protection devices shall be selected based on Table 5. The class of the HPD shall be chosen to suit the given exposure (not merely the highest class possible) to balance sufficient protection and avoidance of overprotection (see Clause 7.5 and Tables 3 and 5). Note that L designations are included for Class A and B devices, as in AL and BL, to designate HPDs with high amounts of low-frequency attenuation suitable for noises with substantial low-frequency content.

7.12.2.2 How class is used to choose a hearing protector

To select a hearing protection device for a given noisy environment using the class, only noise exposure measurement (L_{EX,8} dose using a 3 dB exchange rate) shall be used — that is, equivalent full-shift values. Sound pressure levels or instantaneous noise measurements are inadequate, as they do not provide an estimate of the real hazard of noise exposure to an individual (e.g., the likelihood of damage to hearing). The purpose of the class system is to be able to match a hearing protector to a known noise exposure. Such absolute determinations require the actual hazard to be known. Sound pressure levels alone, in the absence of estimates of duration of exposure, do not provide such information.

Table 5
Selection of HPDs based on class and noise exposure, presuming a desired effective exposure of $L_{EX,8} = 85$ dBA when the HPDs are worn
 (See Clauses 7.11, 7.12.2.1, 7.13, and H.1.)

$L_{EX,8}$ (dBA)	Recommended class
≤ 90	C
> 90 up to and including 95	B or BL
> 95 up to and including 105	A or AL
> 105	Dual*

* Dual hearing protection shall be used. A minimum of a Class B earmuff and a Class A earplug shall be used. Also, it is recommended that exposure durations be limited, octave-band analyses be conducted for attenuation predictions, and more frequent audiometric testing be provided.

Notes:

- 1) The values in this Table reflect an approximate built-in 10 dB derating.
- 2) When using class to match an HPD to a noise exposure, devices with the L designation should be selected when noises have a substantial low-frequency content and shall be selected when the low-frequency content is sufficient that dBC minus dBA value is ≥ 7 dB (as is the case in about 10% of industrial noises).

7.12.3 Single number ratings: NRR and $SNR(SF_{84})$

7.12.3.1 General

The single-number method computes a value of attenuation, in decibels, from laboratory attenuation measurements. The noise reduction rating (NRR) is computed from experimenter-fit ANSI S3.19 data, as described in a U.S. regulatory document (EPA, 1979). The $SNR(SF_{84})$ is described in Annex A of CSA Z94.2. As the SNR is computed from inexperienced-subject fit data (per Method B of ANSI/ASA S12.6), it does not need to be derated.

7.12.3.2 NRR

It has been widely recognized that the NRR substantially overestimates the attenuation that can be achieved under field conditions — more so for earplugs than for earmuffs. Various derating factors, absolute decibel values, or percentage deratings have been proposed, but each approach has limited accuracy in predicting what a group — or especially an individual — will achieve in practice. Nevertheless, some amount of derating is needed to provide some degree of predictability from the experimenter-fit laboratory data. For the purposes of this Standard, Table 4 provides guidance on how to derate and apply the NRR.

7.12.3.3 $SNR(SF_{84})$

The $SNR(SF_{84})$, which stands for single number rating (subject-fit 84th percentile), is computed from test results derived from inexperienced-subject fit ANSI/ASA S12.6 Method-B data. It is a value that theoretically should be achieved in a workplace with a well-run hearing conservation program by approximately 84% of the using population. The $SNR(SF_{84})$ is subtracted from the C-weighted sound pressure level or C-weighted sound exposure of the noise to calculate the effective A-weighted sound pressure level or exposure when the HPD is worn. $SNR(SF_{84})$ can be used with either levels or exposures. The $SNR(SF_{84})$ potentially provides greater accuracy than the class system and NRR because of the more realistic data that are used for the computation. It requires use of C-weighted sound measurements. If A-weighted sound pressure measurements or A-weighted $L_{EX,8}$ exposures are used, a 3 dB adjustment is necessary. An example of the computation is Protected level = noise exposure [noise

level] – SNR(SF₈₄). For a protector with an SNR(SF₈₄) of 26 dB and a noise exposure of 95 dBC the calculations would be:

Protected level = 95 dBC – 26 dB = 69 dBA.

Alternatively, if exposures are measured in dBA, the calculation is:

Protected level = 95 dBA – (26 dB – 3) = 72 dBA.

7.12.4 Octave-band computation

The octave-band method is the most complex of the methods described in this Standard, but it provides the greatest potential accuracy, as long as the measured noise levels are representative of the entire work shift noise exposure. It is a straightforward calculation involving the equivalent workplace octave-band sound pressure levels and the octave-band attenuation data for the hearing protection device being assessed. Although it is sometimes thought of as an “exact” reference method, it has its own inherent inaccuracies, since it is based on mean sound attenuation values and standard deviations for a group of subjects, and not the specific sound attenuation values for the individual person in question. Depending on the data sources, the octave-band computation method may be derated. The octave-band procedure is described in Annex B of CSA Z94.2.

As specified in Clause 9.6.6.2 of CSA Z94.2, the octave-band procedure should be used for maximum potential accuracy, but, in general, its use is not necessary. However, this method shall be used to determine exposures above an L_{EX,8} of 105 dBA. It might be necessary for the administrator to obtain assistance from a subject-matter expert to apply this specialized procedure.

7.13 Double protection

For sound exposure levels in excess of L_{EX,8} 105 dBA, a single hearing protection device will not suffice to reduce the exposure below the recommended limit of L_{EX,8} greater than 85 dBA. For this reason, where 8-h equivalent noise exposure levels exceed 105 dBA, double (also called “dual”) protection shall be used — earplugs in combination with earmuffs. If the administrator is using class to determine the effectiveness of their hearing protectors, then a minimum of a Class A earplug is to be used with a minimum of a Class B earmuff. When class is used, Table 5 provides guidance on usage of double protection. If the noise measurement for a particular location indicates a preponderance of low-frequency (125 Hz and 250 Hz) noise, a Class AL earplug should be used with a minimum of a Class B earmuff.

When NRR is used, Table 4 provides guidance on usage of double protection.

For example, selecting an earplug with an NRR of 33 dB to use in combination with an earmuff with an NRR of 30 dB results in the following calculation:

$$(33 \text{ dB} + 5) \times 0.65 = 24.7 \text{ dB}$$

That rounds to 25 dB. Since noise exposure is most often measured on the “A” scale, 3 dB needs to be subtracted. Therefore, the effective value is 22 dB (see Notes 2 and 3 to Table 4). For an exposure of 105 dB, 22 dB is subtracted, yielding an effective exposure of 83 dBA.

Note: The derating factor of 0.65, used to calculate the real-world attenuation of a double-protection combination, can be found in Table 4.

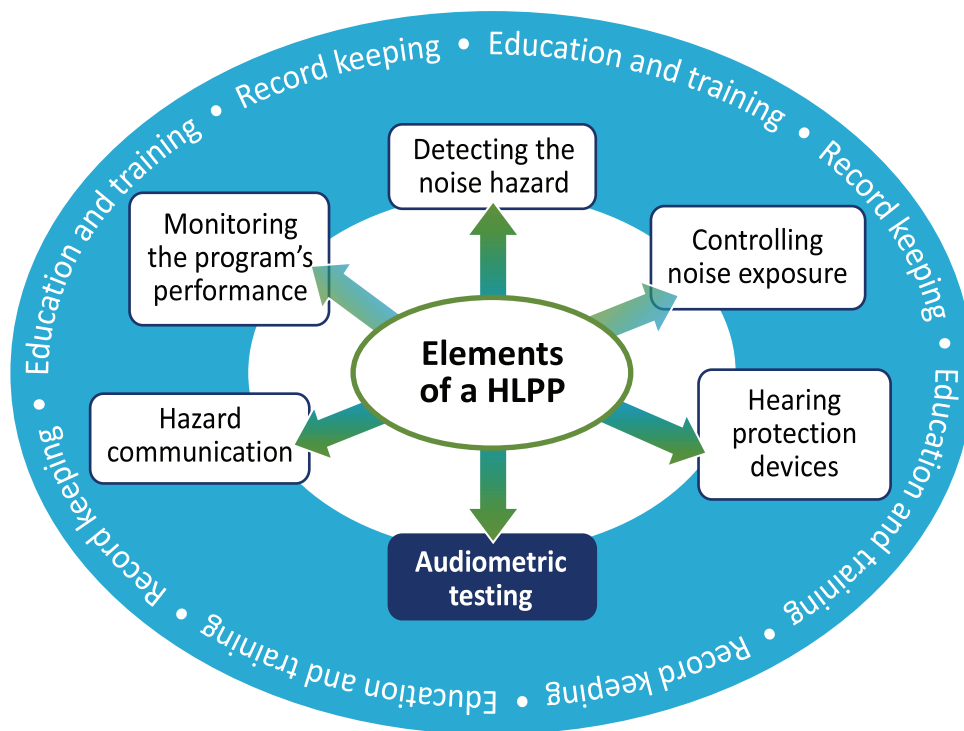
When SNR(SF₈₄) is used, when selecting an earplug with an SNR(SF₈₄) of 24 dB to use in combination with an earmuff with an SNR(SF₈₄) of 18 dB, the dual protection can be presumed to be 5 dB greater

than the attenuation provided by the higher attenuating of the two HPDs (i.e., 29 dB). Since noise exposure is most often measured on the “A” scale, 3 dB needs to be subtracted, giving a final result of 26 dB.

For exposures where double protection is required (i.e., over 105 dBA), great care should be taken in selecting the protectors to use. Where the worker’s exposure was measured with the “A” scale, see the example above.

Selecting the highest-rated protectors only affords protection to an exposure of 105 dBA. At these exposure levels, the administrator shall ensure that the additional measures provided above are implemented.

8 Audiometric testing (hearing tests)



8.1 Audiometric testing programs

8.1.1 General

Long-term exposure to excessive occupational noise can cause permanent hearing loss through sensory-neural damage in the cochlea, the organ of hearing. Typically, hearing is first affected in the mid-range of audible frequencies (3000 to 6000 Hz). Damage grows more rapidly in the years of initial exposure, spreads to other frequencies over time, and becomes more severe. It is therefore important to pay attention to hearing thresholds, particularly any changes in the mid-range frequencies in the years of initial exposure.

8.1.2 Types of audiometric tests

To monitor changes in hearing, two types of audiometric tests should be part of an HLPP, as follows:

- a) Reference test — The reference test is the test against which future tests [e.g., monitoring tests, covered in Item b)] are compared. Typically, the initial reference audiometric test is a baseline audiometric test obtained as outlined in Clause 8.2.2.1. If a standard baseline test is not available, an alternative previously obtained test may be used as the reference test for determining whether a change in hearing has occurred. This could be a test obtained from a previous employer, or a previous test that does not meet the requirements outlined in Clause 8.2.2.1.
- b) Monitoring test — Monitoring tests are the periodic tests that are used to determine whether a shift in hearing thresholds has occurred since the time of the reference test. Monitoring (surveillance) audiograms serve two main purposes when compared to a reference test: they provide individual information about any changes in an individual worker's hearing, and they provide group information that may be used by the administrator to help determine whether the HLPP is effective.

Note: Unlike a baseline audiogram, which should be done prior to noise exposure, it is now recommended that monitoring (surveillance) audiograms be obtained during or after the work shift, in order to identify any temporary threshold shift (TTS) in hearing level before the threshold shift becomes permanent. Warning: The presence of TTS might only become apparent in noise-exposed individuals with normal or near-normal hearing. Individuals with hearing loss show decreased or no TTS for equivalent noise exposures. Thus, the absence of TTS does not necessarily mean a hearing-safe workplace.

8.2 Provision of audiometric tests

8.2.1 General

The administrator shall provide the audiometric tests described in Clauses 8.2.2, 8.2.3, and 8.2.4 for those workers in a workplace setting where exposure levels exceed 85 dBA $L_{EX,8}$.

Notes:

- 1) The attendance of workers for periodic monitoring tests provides a useful opportunity for individual counselling and education, and time to examine the condition of hearing protectors and ensure that they are being worn properly. Workers should therefore be requested to bring their HPDs whenever they have an audiometric test.
- 2) For more information on audiometric testing, see CSA Z107.6.

8.2.2 Reference audiometric test

8.2.2.1 Baseline test

The baseline test

- a) should be conducted after a period away from noise (the recommended period is 12 to 14 h), typically before the work shift;
Note: This period of quiet before the test is intended to ensure that the audiogram represents the worker's best hearing, free from temporary threshold shift due to exposure to workplace noise. The use of HPDs in a noisy environment is not the same as a period of quiet, and cannot be used as an alternative to this period away from noise.
- b) should be conducted before employment in hazardous noise or as soon as practicable, ideally within 30 days; and
- c) shall be conducted within six months of commencing employment in a workplace where hazardous noise exists.

The administrator should be aware that occasionally, the baseline test could be revised when a change in hearing is confirmed. The audiometric technician would use this revised baseline as the reference test.

8.2.2.2 Other reference tests

If the audiometric technician uses a test other than a test conducted in accordance with Clause 8.2.2.1 as a reference test, this should be noted in the results. The administrator should ensure that a baseline test, obtained in accordance with Clause 8.2.2.1, is obtained as soon as possible.

8.2.3 Monitoring (surveillance) audiograms

8.2.3.1 General

Monitoring audiograms should be

- a) conducted annually;
- b) conducted during or after the work shift;
- c) conducted more frequently if noise levels exceed 105 dBA $L_{EX,8}$; and
- d) conducted more frequently if workers could be overexposed to combined agents (e.g., ototoxic agents in addition to vibration and noise).

8.2.3.2 Reduction in frequency of monitoring tests

If in four consecutive annual tests it is documented that an individual worker has

- a) no change in hearing identified by the audiometric technician;
- b) no change in HPD type and use; and
- c) no increase in noise exposure,

testing may be reduced to biennial testing (i.e., every two years) if the worker is exposed to less than or equal to 105 dBA $L_{EX,8}$, and to annual testing if the worker is exposed to greater than 105 dBA $L_{EX,8}$.

A typical monitoring schedule will be resumed if a change in any of the parameters noted above (i.e., hearing thresholds, HPDs, or noise exposure) occurs.

If the frequency of testing is reduced and is conducted biennially, the administrator should be aware that individual education/training and HPD inspection shall still be conducted annually (in accordance with Clause 10).

8.2.4 Exit audiogram

When possible, an exit audiogram should be conducted prior to removal from the HLPP or termination of employment. The exit audiogram should be conducted after a period away from noise, typically before the work shift, similar to the baseline test.

8.3 Audiometric technician

The administrator shall ensure that the audiometric tests are performed by an audiometric technician (as defined in Clause 3) who shall

- a) complete at minimum the necessary training, as outlined in CSA Z107.6, and demonstrate credentials or licensing to this effect;
- b) ensure that testing equipment is maintained and calibrated consistent with CSA Z107.6;
- c) document any situation that could compromise the validity of test results;
- d) obtain air-conducted hearing thresholds for each ear, following the procedures outlined in CSA Z107.6;

- e) provide a copy of the audiogram to the worker and explain the meaning and implication of the results to the worker in terms he or she understands, or ensure that this occurs;
- f) ensure that individual audiometric test results are filed securely and kept confidential (for the information of the individual tested and permitted use of the administrator);
- g) provide, or ensure that the workers have received, guidance on selection, fit, and maintenance of HPDs, and counsel the workers on the condition of their HPDs;
- h) provide the administrator, where legislation permits, a list of workers who have been identified with hearing loss at the time of the baseline audiogram;
- i) where legislation does not permit the identification of specific worker test results, provide a general analysis as outlined in CSA Z107.6 of the test results;
- j) provide the administrator, where legislation permits, a list of workers who have experienced a reduction in hearing consistent with NIHL based on a comparison of the monitoring and reference audiograms;
- k) where legislation does not permit the identification of specific worker test results, provide a general analysis, as outlined in CSA Z107.6, of the test results indicating whether the HLPP appears to be preventing hearing loss consistent with NIHL;
- l) refer the worker for medical follow-up if audiometric test results indicate it is necessary, and include the referral in their records; and
- m) if a worker requires modification to the selection of HPDs, include this in the report to the administrator, or ensure that the required modification occurs.

Note: At the time of publication of this Standard, CSA Z107.6 is under development and will include guidance to the audiometric technician on conducting and interpreting audiograms.

8.4 Use of the audiometric test results

The administrator shall review the general analysis and/or individual results provided by the audiometric technician.

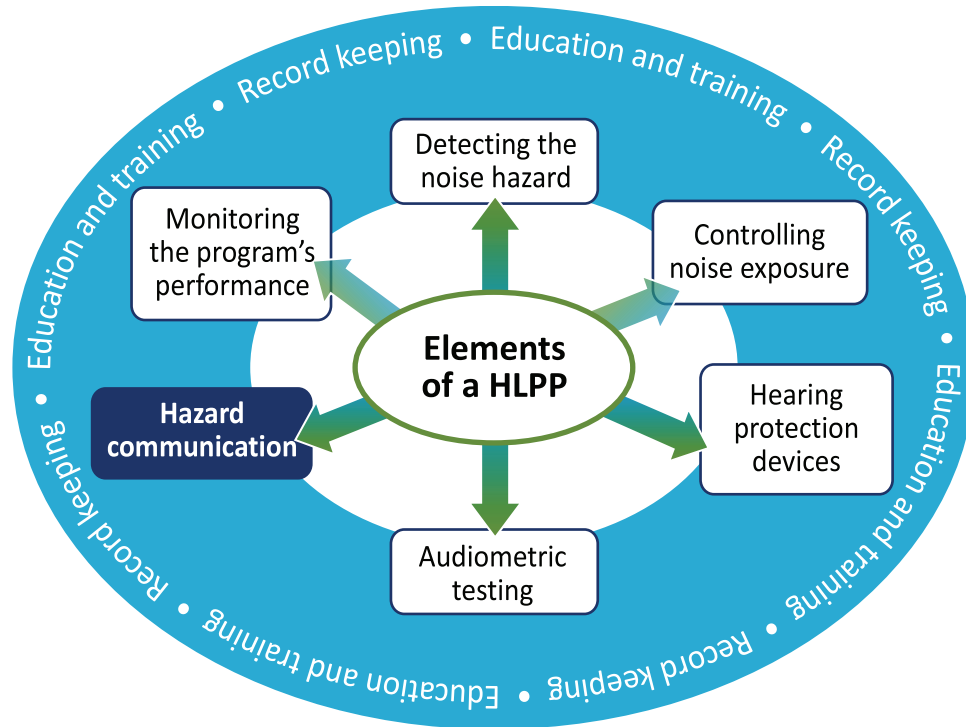
When the general analysis or individual results from the monitoring audiogram indicate a hearing threshold shift consistent with noise exposure, the administrator shall

- a) address patterns or trends if more than one worker demonstrates a threshold shift consistent with noise exposure;
Note: For example, if most of the workers who work in a specific area of a job site use similar equipment, wear similar HPDs, or are in the same age bracket show signs of hearing loss consistent with noise, the administrator should focus on addressing issues that relate to these areas or groups.
- b) ensure that the process for following up such an audiogram with a healthcare professional, as specified in CSA Z107.6, takes place;
- c) review the job of the worker or group of workers to identify any changes that might have caused an increase in exposure to noise, and if necessary, re-test noise exposure;
- d) determine whether any engineering or administrative controls can reduce the levels or duration of noise to which the worker or group of workers is exposed;
- e) verify that adequate HPDs have been selected for the worker or group of workers, that the HPDs are not damaged, that the worker(s) is/are able to fit them correctly, and that they wear their HPDs consistently while in hazardous noise;
- f) verify that speech-enhanced, level-dependent, or radio-connected HPDs are supplied if required for communication or safety needs;
- g) ensure that affected workers or groups of workers are well-informed and motivated to protect their hearing; and

h) document all of the above.

Note: At the time of publication of this Standard, CSA Z107.6 is under development and will include guidance to the audiometric technician on conducting and interpreting audiograms.

9 Hazard communication



9.1 Warning signs

A clearly visible warning sign (see Figure 17) shall be posted at every approach to any area in the workplace in which the sound level regularly exceeds 85 dBA.

Figure 17
Hazard warning sign
(See Clause 9.1.)



The purpose of the signage is to advise the workers that they are entering an area that is, or might become, loud enough to cause damage to their hearing if unprotected, depending on the length of time they spend in the area. The intent is for the employer to post a sign where continuous or intermittent noise levels regularly exceed 85 dBA due to work that is normally conducted in the area. This would include intermittent noise from power tools or equipment normally used in the area.

Warning signs shall instruct workers to wear hearing protection. Hearing protection devices, appropriate to the noise level, shall be made available close to, but outside of, the areas of hazardous noise.

9.2 Notification to workers

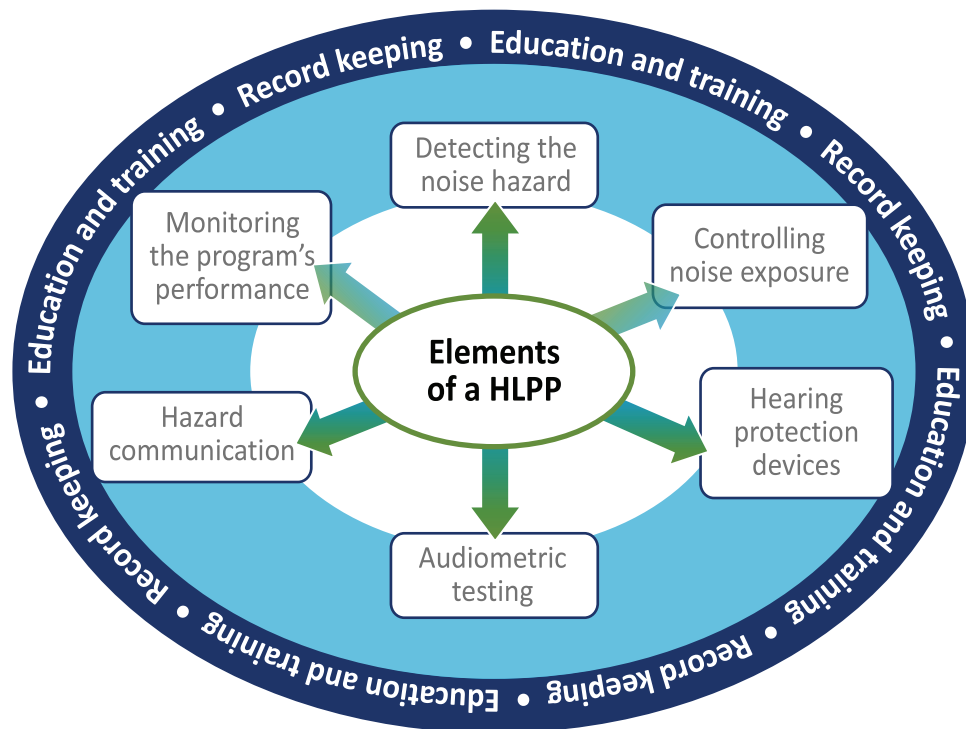
The administrator shall inform workers of all noise sources in the workplace that the workers might be exposed to as well as the sound levels, and shall also notify them when noise testing will be conducted.

Workers shall be familiar with the layout of noise-emitting equipment and tasks in their work area.

Workers shall be trained to understand the meaning of warning signs, and their location, as part of the hearing loss prevention training program in accordance with the education and training described in Clause 10.

Note: As stated in Clause 4.10, workers also have a responsibility to report any high-noise sources or activities creating intermittent high-noise conditions that might not have been identified on previous noise surveys.

10 Education and training



10.1 General

The success of an HLPP depends largely on effective education and training of everyone who is involved in the various aspects of the program.

As illustrated above, education and training shall be incorporated at every stage of the HLPP. For the purposes of this Standard, education is defined as the knowledge and theory behind the HLPP. Training is defined as developing the skills necessary to effectively implement the aspects of the HLPP necessary to keeping the worker safe. Informing workers about the elements of the program, and why they are necessary, will ensure understanding and make training easier. Education and training can be

incorporated into short crew talks for workers, or can be conducted at the time of annual audiometric testing, and shall be part of the health and safety training provided to new (or newly transferred) workers. Education shall recur at least every two years, and whenever job duties or equipment changes in any way that affects noise exposure levels. Skills refresher training should be conducted annually (see Clause C.1.6).

The primary focus of the education and training components of the HLPP is on workers. They need to be informed about the reasons for and the requirements of the HLPP at the time they join the workforce. Education and training shall be ongoing and reinforced at least annually or as changes occur in the workplace.

10.2 Worker education

10.2.1

The education shall be tailored to the specific exposure and prevention needs of each worker or group of workers. At a minimum, workers should understand the requirements and rationale of this Standard. It should also be designed to help workers understand strategies for reduction of exposure to noise. Education to workers should include

- a) results of noise surveys and measurements taken in the workplace;
- b) effects of noise on hearing and the risks posed by the noise levels in the workplace;
- c) the organization's policy for elimination of the noise as a hazard, including noise controls implemented;
- d) the basic principles of noise control and their application in the workplace;
- e) the purpose of hearing protection devices, and information that unless hearing protection devices are worn above 85 dBA $L_{EX,8}$, there is some risk of hearing loss;
- f) information that a hearing protection device's effectiveness is greatly reduced if it is removed even for short periods;
- g) manufacturer's instructions for use, and if necessary, additional information regarding use in particular situations and compatibility with other protection devices such as respirators, welding helmets, goggles, etc.;
- h) information about how to report any failures in noise control measures or work process conflicts;
- i) requirements and rationale for audiometric testing; and
- j) individual responsibility for preventing hearing loss, including the mention of non-occupational noise sources.

10.2.2

Despite the emphasis on worker education, strong management support is critical and shall be more than just approval of the organization's policies. For this reason, this support shall be an outward, active show of approval and compliance with established policies, and shall be clearly evident to lower management, supervisors, and workers. Management should be educated about the need for and the elements of the program, as well as

- a) the basics of the legal and professional requirements for an effective HLPP;
- b) administrative requirements for compliance and liability consequences of noncompliance;
- c) the financial benefits of the program on workers' compensation costs, improved productivity, and worker retention; and
- d) their duty and the process for reporting noise control measure failures or clashes between the noise control measures and operational processes.

In addition to workers and management, all other members of the HLPP team, including healthcare professionals who conduct follow-up examinations, shall be educated about the organization's policy for the program and their role in it as listed in Table 6 and in Clause 10.4.

10.3 Worker training

Training is the hands-on (practical) component of education, and is part of the HLPP. The administrator shall ensure that workers are provided with training sessions at least every year, and shall include the following topics:

- maintenance and inspection of noise control devices (e.g., mufflers and noise barriers);
- monitoring the performance of equipment they use and advising the administrator when changes to the noise level of equipment or the work environment are apparent;
- for all personnel who use HPDs, information and hands-on (practical) training on how to fit (see Clause 7.4) and how to maintain HPDs (see Clause 7.8);
- for all personnel who use HPDs, the proper cleaning of HPDs and hands during handling, and proper storage of HPDs in a suitable environment; and
- developing a culture that encourages individuals to help each other achieve the team goals for accident elimination and illness reduction, and making informing a positive part of what fellow workers do for each other.

Team members responsible for training workers shall themselves be trained in such things as fitting hearing protection devices and training workers in their proper use.

The summary of the training matrix, as provided in Table 6, is intended to describe the training competencies required to fulfill the roles and responsibilities listed in Clause 4. In many organizations, one person might fulfill more than one defined role, and will therefore require multiple competencies.

Table 6
Clause references for education and training
(See Clauses 10.2.2 and 10.3.)

Position	Roles and responsibilities	Noise survey results	Effects of noise on hearing	Purpose of audiometric test	HPD selection process	Fitting, care and practical use of HPD	Limitations of HPD
Employer	4.3, 4.7						
HLPP administrator	4.4, 4.12	11.4, 11.7	0.7	8	7.1 – 7.3, 7.10	7.4 – 7.9	10.5, C.1.5
HLPP evaluation	11						
HPD user	4.6, 4.10	11.3, 11.5	0.7	8		7.4 – 7.9	
Supervisor of HPD user	4.3	11.3, 11.5	0.7	8		7.4 – 7.9	10.5, C.1.5
Person selecting HPD	4				7.3 – 7.5	7.4	C.1.5
Audiometric manager	8						
Audiometric technician	4.14, 8.3						

Note: Most of the information that those involved in noise exposure measurement or its management need is contained in CSA Z107.56.

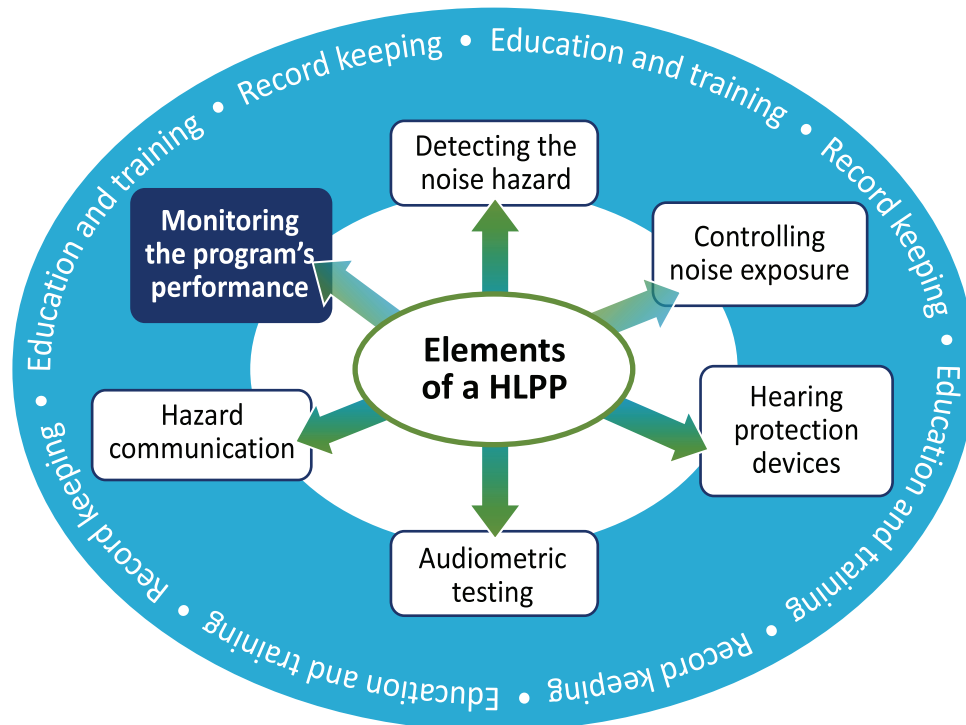
10.4 Maintenance of a culture of hearing loss prevention

Workers shall be made aware that it is the organization's responsibility to take actions to control noise exposure, and where these actions do not hit the target under-protector exposure level, provide hearing protection and train workers in its use. Workers shall also be made aware that the effectiveness of these noise control measures and the use of hearing protectors are significantly compromised if the HPDs are not used and maintained properly. As stated in Clause 4.6, on-the-job hearing loss prevention is a joint responsibility between management and workers. However, hearing loss prevention also includes management of off-the-job exposures to noise. Consequently, the training provided shall encourage workers to protect their hearing both on and off the job. A culture of hearing loss prevention shall be maintained at the workplace, and workers shall be encouraged to support one another in that effort.

10.5 Workers with hearing loss

Workers that have suffered hearing loss might be at greater risk than the general population because of their inability to hear warning sounds, backup alarms, etc., while wearing hearing protection. Special training is necessary for those workers to give them the skills necessary to keep them safe. The administrator shall establish, implement, and maintain special training programs for workers with hearing loss to ensure that they are safe to work. See Clause 12.3.2 for topics that should be considered for this training.

11 Monitoring the HLPP's performance



11.1 General

To evaluate its effectiveness, the HLPP shall be reviewed under the responsibility of the administrator and the findings of the review documented at least annually. In addition, periodic reviews, triggered by

events that change the parameters of the HLPP, are a proactive way of ensuring HLPP effectiveness (see Annex J). A standard annual review shall include the elements listed in Clauses 11.2 to 11.6.

Note: The monitoring of HLPP performance should be done in accordance with the principles of program monitoring specified in CAN/CSA-Z1000.

11.2 Visual inspection

Visual inspection of the workplace facilities shall be conducted as part of the annual review. Inspections shall answer the following questions:

- a) Does equipment appear to be operating properly?
- b) Do existing noise controls appear in good condition and in use?
- c) What, if any, repairs or modifications are required?
- d) Are signs indicating noisy areas visible and appropriate?
- e) Do HPDs appear to be worn properly at all times in hazardous areas?
- f) Have engineered or administrative controls been altered, thereby reducing their effectiveness?

11.3 Discussion with workers and supervisors

Examples of the questions the reviewer should ask workers and supervisors are as follows:

- a) Has there been a change in the production methods, equipment used, operating conditions, or hours of operation that would affect the noise?
- b) Are they aware of any changes in noise levels, and do they have any concerns?
- c) Are they aware of any breakdown or failure of noise control measures?
- d) Is the hearing protection they are currently using interfering with any other personal protective equipment they use?
- e) Is the hearing protection they are currently using interfering with communication?
- f) Is the hearing protection they are currently using comfortable?
- g) Was training and education provided regarding noise and hearing loss?
- h) Does the individual know their results for the most recent audiometric test and the implications of the results?

11.4 Periodic noise level and noise exposure measurements

Comprehensive noise level and noise exposure measurements, with the same requirements as those conducted at the initial assessment (see Clauses 5.2, 5.3, and 5.4), shall be conducted when changes in the workplace equipment or procedures or aging and wear of the equipment that might affect noise exposure occur, or at minimum every two years.

As part of the annual review, findings from the most recent measurements should be documented, and the need for further measurements should be assessed. The following are some of the indications that measurements should be repeated more frequently than every two years:

- a) concerns are revealed during periodic visual inspections;
- b) new installations, equipment removal, or retrofitting of equipment that could change noise levels;
- c) changes in equipment operating conditions (e.g., load, time of use), age, wear, maintenance, production methods, or processes that could alter either noise levels or exposure times; and
- d) changes in the facility or building structure or layout affecting sound propagation, such as altered wall, floor, or ceiling coverings, new partitioning, and moving of equipment.

In addition, individual risk assessments should be reviewed whenever working arrangements are modified so as to affect the length of time that the workers are exposed.

The organization should modify the HLPP whenever there is a change at the facility. Every change will likely result in a change to someone's noise exposure. Consequently, the organization should anticipate these changes and proactively make adjustments to the program.

11.5 Outcome measures

11.5.1 General

To help the administrator determine whether the HLPP is effective or to help focus efforts, numerous outcome measures can be employed. Proactive measures, designed to improve the HLPP before hearing loss occurs, should precede audiometric testing (hearing tests) as a measure of the HLPP's effectiveness. Annex J was developed to aid with this process.

11.5.2 Worker questionnaires

The organization should consider providing workers with questionnaires to ensure that they understand their roles and responsibilities within the HLPP.

11.5.3 Spot checks

Results from random spot checks provide valuable outcome measures for assessing the effectiveness of the HLPP. Rather than waiting for audiometric test results to advise of a problem with the HLPP, the organization should conduct regular visual inspections to determine if all aspects of the HLPP have been implemented (see the checklist in Annex J). Spot checks should include the following:

- a) Use of hearing protection — The administrator should ensure that all workers are wearing HPDs appropriately. If the HPD does not appear to fit correctly, attempts to find the appropriate HPD for that worker's ear(s) and work shall be made.
- b) Verification of attenuation — When possible, the administrator should measure the attenuation of the worker's HPD by removing the worker from the noise and testing the attenuation of their HPDs, in place. This attenuation measure should be compared against previous attenuation measures gathered from previous tests and tracked and recorded over time. Their relative result will indicate whether workers are consistent in fitting their hearing protection and gaining the required attenuation. An FAES (or fit testing system) is useful in this regard.

Note: ANSI/ASA S12.71, which is under development at the time of publication of this Standard, will address the accuracy of FAES measurements. FAES are effective for making comparable measurements over time and thus giving the administrator some idea of the changes in how workers fit their HPDs.

11.5.4 Worker participation

In accordance with the principles of worker participation in CAN/CSA-Z1000, workers shall be engaged in the HLPP. They should understand the value of joint responsibility for protecting their hearing (i.e., reducing risk of hearing loss). Accordingly, the administrator shall include worker responsibility for participation in the HLPP in their training and education (see Clauses 4.10 and 10).

11.5.5 Audiometric test results

To monitor the performance of an HLPP, a database of audiometric test results can give a clear picture of whether the HLPP is achieving its goal. The effectiveness of the HLPP should be evaluated in terms of the hearing loss prevented for each worker, and the overall rate of hearing loss prevented in the population of workers. This is very difficult to determine, however, as years of data and the use of statistical tools would be required. By the time trends are validated, the hearing loss has already occurred.

While audiometric test results are important to monitor and identify hearing loss consistent with noise exposure and can assist with targeting areas or groups of workers requiring further intervention, a more proactive means of gauging the program's effectiveness should be attempted (see Clauses 11.1 to 11.4).

11.6 Record-keeping

The organization shall keep records to indicate that each element of the HLPP has been employed and monitored on an annual basis. These records should include the following:

- a) roles and responsibilities of each member of the HLPP team;
- b) results of noise exposure measurements taken;
- c) assurance that individual audiometric test results are filed securely and kept confidential (for the information of the individual tested and permitted access of the administrator);
- d) education and training provided to workers;
- e) engineering or administrative control measures, including reasoning if no or few measures have been implemented;
- f) concerns raised regarding noise levels, hearing loss, or other related issues; and
- g) efforts made to address findings and concerns.

11.7 Continuous improvement

Continuous improvement of the HLPP comes from continuously setting higher standards for the program and finding ways to achieve them. Improving the HLPP can begin with program changes, but ultimately requires working one-on-one with those in the program. The following are some of the ways the HLPP can be improved:

- a) Reassess the workers' exposures — Only when their exposures are known can improvements to protection be achieved.
- b) Set a lower noise exposure action level — If a worker's noise exposure outside of work contributes substantially to their daily noise exposure, it might be beneficial to set a lower target exposure limit for those workers. Furthermore, for those workers who are highly sensitive to noise in terms of annoyance or actual susceptibility, it might be helpful to set their individual target exposure limit significantly lower (for the provision of education and availability of hearing protection specifically designed for these workers).
- c) Compare groups of records within the program — To provide greater ability to estimate the effects of noise on an industrial population, a best practice is to have a population that is not exposed to industrial noise for comparison purposes. This can be most effectively accomplished when the organization extends audiometric testing to their entire population, industrial noise exposed and non-noise-exposed, in order to develop an internal reference database. This also can provide a valuable health benefit to all workers.
- d) Buying quiet and building quiet — Encourage management to incorporate "Buy Quiet" norms in the purchase of equipment for the facility (see CSA Z107.58). Refer to Clauses 6.2.3 and 6.2.4 for use of engineering controls to reduce noise exposure.

Note: Health Canada also has a recommendation on buying quiet equipment at: <http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/machinery-machines-eng.php>. Further information on accessing and setting standards for quiet equipment can be found in NIOSH's Criteria for a Recommended Standard: Occupational Noise Exposure (Revised Criteria 1998) and Health Canada's "Noise from Machinery Intended for the Workplace" (<http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/machinery-machines-eng.php>).

12 Special challenges

12.1 General

Successful implementation of an HLPP can be hindered by challenges inherent in certain work environments or with certain worker groups. These include workplaces with fluctuating noise levels, workplaces where the ability to communicate is critical (e.g., law enforcement), workplaces that are intentionally loud (e.g., entertainment venues), and workplaces where noise control is particularly difficult (e.g., firing ranges, underwater welding). Challenges can also arise where the workforce is transient (e.g., construction or agriculture, temporary agency workers), making both tracking and compliance more difficult. Any workplace can present special challenges for workers who already have hearing loss. When in doubt, to reduce the risk of hearing loss to workers, the administrator should ensure that the elements of the HLPP are implemented. Outlined in Clauses 12.2 and 12.3 are some points to be considered when these challenges are present.

12.2 Workplace challenges

12.2.1 Communication in noise

Workers might be tempted to remove their HPDs to talk to other workers when they feel that their ability to communicate is impaired by the HPD. However, if HPDs are removed, even for a brief period of time, their effectiveness is greatly reduced (see Clause 7.6). For this reason, the organization shall ensure that specialized equipment, hearing protection, and training are provided to workers with communication needs in hazardous noise.

If workers need to communicate in noise, they should be fitted with hearing protection or devices that enable interpersonal communication or radio communication in noise. Clauses 7.3.5.2 and 7.3.5.3 describe hearing protection that facilitates face-to-face communication. Clause 7.3.5.4 describes hearing protectors that facilitate better radio communication.

12.2.2 Workplaces where noise exposure is difficult to measure

The nature of some employment settings can pose challenges for traditional noise exposure assessment techniques. Day-to-day variations in environment, short-duration high level exposures, varying shift lengths, and varying worksites all contribute to the challenges.

In situations where the noise fluctuates throughout the day based on use of various tools, equipment, and environmental noise, it is best to measure noise levels generated by each activity and calculate the $L_{EX,8}$ expected based on the activities, the noise levels in the environment, the length of the work shift, and the estimated duration of exposure. The noise level data should come from noise measurements done using a dosimeter or integrating sound level meter. Refer to Clauses 5 and 6 for further information and guidance on noise assessment and control (see also CSA Z107.56 for details on these strategies).

12.2.3 Workplaces with difficult-to-control noise

12.2.3.1 Intentionally loud workplace noise

In the entertainment industry, such as in nightclubs, in pubs, at live music concerts, and at sporting events, workers are often exposed to intentionally loud amplified music, which represents a risk to their hearing. In addition, it can be difficult finding suitable hearing protection that workers are willing to wear. Many workers in these settings believe that HPDs will hinder their ability to communicate with

patrons (e.g., bartenders), and therefore resist HPD use. Education aimed at dispelling this belief should be a part of the HLPP.

Hearing protection that attenuates equally across frequencies, often referred to as “musicians’ earplugs”, should be considered as part of the program. It should also be noted that, typically, HPDs improve the ability of normal-hearing listeners to discriminate speech in high-noise environments. This effect is not found for listeners with hearing loss (see Clause 12.3.2 for guidance on hearing loss prevention strategies for workers with hearing loss).

12.2.3.2 Workplaces with exceptionally high sound levels

There are workplaces where the noise levels are particularly high, such as at airports and firing ranges. These workers can be exposed to very high noise levels, depending on the type and size of airplanes, firearms used, activities occurring, and the duration of the exposure. Double hearing protection, in the form of earplugs and earmuffs (see Clause 7.13), is often required to protect these workers. In addition, the administrator should ensure that noise abatement strategies and controls at the noise source have been implemented to reduce transmission of sound both through the air and through the structure. Finally, it might be necessary to use administrative controls (see Clauses 6.3 and 7.9.1) to manage the workers’ exposure and keep their exposure, under-the-protector, to a safe level (see Clauses 7.5 and 7.10.1).

Note: For further information on protecting workers that are exposed to exceptionally high noise levels, see NIOSH 2009-136, Preventing Occupational Exposures to Lead and Noise at Indoor Firing Ranges (www.cdc.gov/niosh/docs/2009-136/).

12.2.3.3 Management of noise exposure in underwater environments

Commercial divers are typically exposed to a range of noise sources, including general ambient underwater noise, and potentially hazardous noise caused by the dive-site activity, self-generated breathing and helmet noise, audio communication noise, and tool and equipment noise. Divers can also be exposed to noise outside of the water, both in compression chambers, many of which exceed 85 dBA $L_{EX,8}$, and at the dive site itself, which is often a noisy environment.

Hearing underwater differs from hearing in air. Because human tissue and water have similar acoustic properties, sound in water is able to propagate into the human body, and it can be conducted to the inner ear through the body as well as through the eardrum (tympanic membrane) and middle ear as it is in air. This makes the protection of hearing in underwater operations a complex issue.

When the work environment requires commercial divers, the administrator should attempt to estimate the total noise exposure of each worker, including the noise exposure from their own equipment and underwater noise exposure. Because of the complexity, a qualified person who is an expert in issues related to underwater exposure should do an underwater noise exposure measurement. As in all cases, if workers are exposed to hazardous levels of noise, the HLPP elements shall be implemented (see Clause 4.1).

As in all HLPPs, eliminating or reducing the noise levels at the source, which often includes the breathing apparatus, is the first method of noise control. If a diving helmet is required, attention should be paid to the helmet and ventilation system design, and attempts should be made to supply quieter models. As communication is often required, and needs to be louder (typically 15 dB) than the background noise, reducing the noise source levels can allow for quieter communication input as well.

The above-mentioned controls can be difficult, and often the only easily controlled method is to restrict the exposure time of the divers.

Recommendations for underwater workers also include, when possible, using a mask as opposed to a helmet, and a neoprene hood for attenuation. Helmets can have acoustic insulation applied to them, and HPDs should be worn under diving helmets when possible. In compression chambers and diving helmets, HPDs should have vents with dampers to accommodate varying air pressure but still provide a degree of hearing protection.

12.3 Worker challenges

12.3.1 Transient or seasonal workforce

12.3.1.1

The factors that affect the ability to implement an effective HLPP in an organization with seasonality are as follows:

- a) transiency of the workforce; and
- b) variability of the organization's operations.

Because an organization with seasonal or variable operations needs to induct new workers often, and cannot retain many individuals for long, maintaining HLPP programs can be challenging. Also, because the workforce varies from period to period, collecting data and managing training is difficult. An organization that relies in part on seasonal or transient workers might find it difficult to implement and enforce all elements of an HLPP. Organizations that operate in this manner should maintain systems to track workers' participation in training, audiometric testing, and HPD selection. They should also develop systems for determining workers' knowledge of the HLPP soon after they begin employment. Alternatively, if these workers are placed by agencies, those agencies may manage the data pertaining to the worker's knowledge of the HLPP.

12.3.1.2

As with other employers, construction employers, agricultural employers, temporary agencies that send workers into loud work environments, and all other employers in industries involving a transient workforce exposed to hazardous noise shall ensure audiometric testing of all workers exposed to greater than 85 dBA $L_{EX,8}$, as outlined in Clause 8. There might be challenges to this regarding who provides the various elements of the HLPP. Ultimately, the employer who pays the salary of the worker is also responsible for providing an effective HLPP, including components such as HPDs, education and training, and baseline and monitoring audiograms.

It can also be difficult to determine when a worker last had an audiometric test, or to compare current results to a baseline test. There are two recommendations to solve this problem, as follows:

- a) It is recommended that construction, and all other transient workers, should retain transportable records of their HLPP training and audiometric test results. Each new employer can then ensure that the worker has had the appropriate HLPP training and an audiometric test within the previous year.
- b) If the worker has not had an audiometric test within the previous year, the employer should provide the audiometric test upon hiring the worker.

Note: Alternatively, a central registry could be set up in the sector or region where this information can be retained and accessed by subsequent employers.

12.3.2 Challenges due to pre-existing hearing loss

12.3.2.1 General

A special challenge occurs when a worker has pre-existing hearing loss caused by noise or other etiologies. Presbycusis, or age-related hearing loss, for example, is very common in workers over the age of 50. The administrator should be aware that any hearing loss can contribute to difficulties communicating, as described in Clause 12.2.1, and workers with hearing loss might be inclined to remove their HPDs in order to communicate and hear warning signals or other sounds in their environment. Workers with hearing loss might also feel that “the damage has been done” and believe that they no longer need to wear their HPDs. In all situations, specialized education might be required, and their specific hearing needs and safety issues should be addressed.

12.3.2.2 Hearing aids in hazardous noise

In general, workers should not wear hearing aids if working in hazardous noise, either as a hearing protector or in combination with hearing protection. Workers might be tempted to wear their hearing aids turned off, with the belief that they act as HPDs. This is not appropriate, as hearing aids are not designed to be HPDs and do not provide sufficient attenuation for the noise exposure. When the hearing aid is on, the hearing aid can amplify the already hazardous noise and cause further hearing loss.

Also, it is not recommended that workers wear hearing aids under earmuffs unless the workers’ audiologist (or other hearing professional) has addressed the issue of the output of the hearing aid under the muff.

When advising a hearing-impaired worker or mandating policy for workers wearing hearing aids in noise,

- a) inform the employees that specialized hearing protectors are available that might benefit workers with hearing impairment;
- b) create a team consisting of the administrator, the hearing-impaired worker, and their hearing healthcare professional to determine the appropriate hearing protection for the hearing-impaired employee. This determination is done on a case-by-case basis. It is necessary to determine whether the worker’s hearing aid can be appropriately worn in a noisy workplace under an earmuff;
- c) individualized audiometric testing protocols might be necessary to obtain valid audiograms. Ensure that the audiometric testing process is revised to test hearing-impaired workers; and
- d) raise awareness about the need to protect the residual hearing of workers with hearing loss.

12.3.2.3 Appropriate hearing protection for those with hearing loss

Passive HPDs worn by workers with pre-existing hearing loss can, in effect, artificially increase that worker’s hearing loss and might reduce that worker’s ability to understand speech or hear auditory warning signals, imposing unreasonable safety risks.

If the administrator is aware that a worker has hearing loss and is working in hazardous noise, the administrator should consider providing hearing protection appropriate for that worker. A number of hearing protection options exist to help these workers function safely and effectively in noise without the risk of further hearing loss. HPDs that should be considered by the administrator include the following:

- a) lower attenuation/sound reduction, such as Class B or C hearing protectors, or devices with lower SNR(SF₈₄)/NRR. There are few Class C products available. The choice, therefore, might be limited to Class B;

- b) specialized devices, as described in Clause 7.3.5, that utilize mechanical techniques, electronic circuitry, microphones, and loudspeakers in various ways to achieve noise reduction or noise reduction and communication; and
- c) flat, or uniform, attenuation earplugs or muffs that provide more consistent sound reduction at all frequencies, or pitches, resulting in more natural hearing.

Because hearing is a sensory capability, not unlike vision, there might be jobs that strictly require the ability to hear while wearing hearing protection. This can preclude workers with existing hearing loss from functioning safely in that particular job. Annex L further discusses some of the difficulties around this complex issue.

Note: *In many jurisdictions, employers have a legal obligation to make adjustments in the workplace for workers with certain, specified disabilities, such as hearing loss. With reasonable accommodation, the worker needs to be able to safely perform the essential functions of the job without posing a direct threat in the workplace. For more information about the specific rules in specific jurisdictions, see Annex F.*

In all cases, the noise exposure for the worker determines which of these options the administrator can choose; these devices might not have sufficient attenuation for the noise exposure of a particular worker. It should also be noted that if the attenuation of an HPD, specialized or otherwise, does not allow the worker to hear safety signals, the administrator should consult with the employer and others who are responsible for worker safety. Visual warning signals might be appropriate, and in some cases, that worker might not be able to safely work in that environment when HPDs are worn, requiring administrative controls to be employed. In some cases, the worker can be relocated to a safer job site or can be scheduled to work at times when hazards are not present.

Annex A (informative)

Ototoxicity

Note: This Annex is not a mandatory part of this Standard.

A.1 Overview

It has been found that exposure to certain industrial chemicals (“ototoxins”) can lead to hearing loss. An ototoxin can be defined as a substance that causes functional impairment or cellular damage in the inner ear (e.g., to hearing or balance) or the eighth cranial nerve, the vestibulo-cochlear nerve. Hearing loss is more likely to occur if a worker is exposed to both noise and ototoxins than if exposure is just to noise or ototoxins alone.

The HLPP should identify these chemicals in the workplace and direct efforts to not only reduce the noise exposure but to reduce the concentrations of the ototoxin to below the occupational exposure limits set by the authority having jurisdiction. Two chemicals in particular are recognized as ototoxic, depending on the concentration: toluene and carbon monoxide.

The most recent edition of ACGIH data on ototoxicity (*ACGIH Threshold Limit Values for Chemical Substance and Physical Agents*) advises:

“Exposure to certain chemicals may also result in hearing loss. In settings where there may be exposures to noise and to carbon monoxide, lead, manganese, styrene, toluene, or xylene, periodic audiograms are advised and should be carefully reviewed. Other substances under investigation for ototoxic effects include arsenic, carbon disulphide, mercury, and trichloroethylene.”

A.2 Other related references

The following are additional ototoxicity references:

- a) IRSST Report R-747, Effect of chemical substances on hearing – Interactions with noise. (<http://www.irsst.qc.ca/media/documents/PubIRSST/R-747.pdf>).
- b) Occurrence in pharmaceuticals — The American Speech-Language-Hearing Association (ASHA) states there are more than 200 known ototoxic medications on the market today (prescription and over-the-counter). Ototoxic medications cause damage to the sensory cells, first manifesting as tinnitus.
- c) Occurrence in work place — Fair to good evidence has been accumulated in animal studies showing that ototoxic effects can occur with workplace chemicals. There are some documents on the interaction of chemicals and noise in humans.
- d) Relevant European legislation:
 - i) Sweden — The Swedish Environment Work Authority published legislation to limit occupational exposure in December 2011, which indicated that some substances are ototoxins. Indicated by a “B” notation, six chemical substances approaching existing professional hygienic limit values, with simultaneous exposure to noise levels approaching the action value of 80 dBA, can damage hearing. These substances include carbon disulfide, carbon monoxide, lead (inorganic), mercury (inorganic, organic), styrene and toluene.
 - ii) Germany — In February 2011, the Noise and Hazardous Substances Working Group on Ototoxic Substances (of the Occupational Medicine Committee of the German Institution for Statutory Accident Insurance and Prevention [DGUV]) concluded when complying with the currently applicable occupational exposure limits, significant hearing loss is unlikely; however,

an increased risk may occur if occupational exposure limits for noise and ototoxic substances are exceeded.

The substances named in the document are ethyl benzene, carbon disulphide, carbon monoxide, hydrogen cyanide and its salts, lead and lead compounds, mercury and mercury compounds, styrene, toluene and p-xylene.

Annex B (informative)

Engineering controls

Note: *This Annex is not a mandatory part of this Standard.*

B.1

The administrator is faced with many competing priorities: preventing NIHL for the workers for which he or she is responsible, costs incurred in managing the program, complexities for executing the program in the particular workplace involved, etc. One of the concerns that the administrator needs to address is how to manage the noise exposure for workers while managing other hazardous exposures. For example, the ACGIH Threshold Limit Values provide recommended limits for many hazardous chemical and biological exposures.

B.2

There is an engineering practice known as noise control, and the basic model used in noise control involves thinking of each noise situation as a combination of the source of the noise, the path for the noise, and the receiver of the noise. In short, this is the “Source – Path – Receiver” model of noise control.

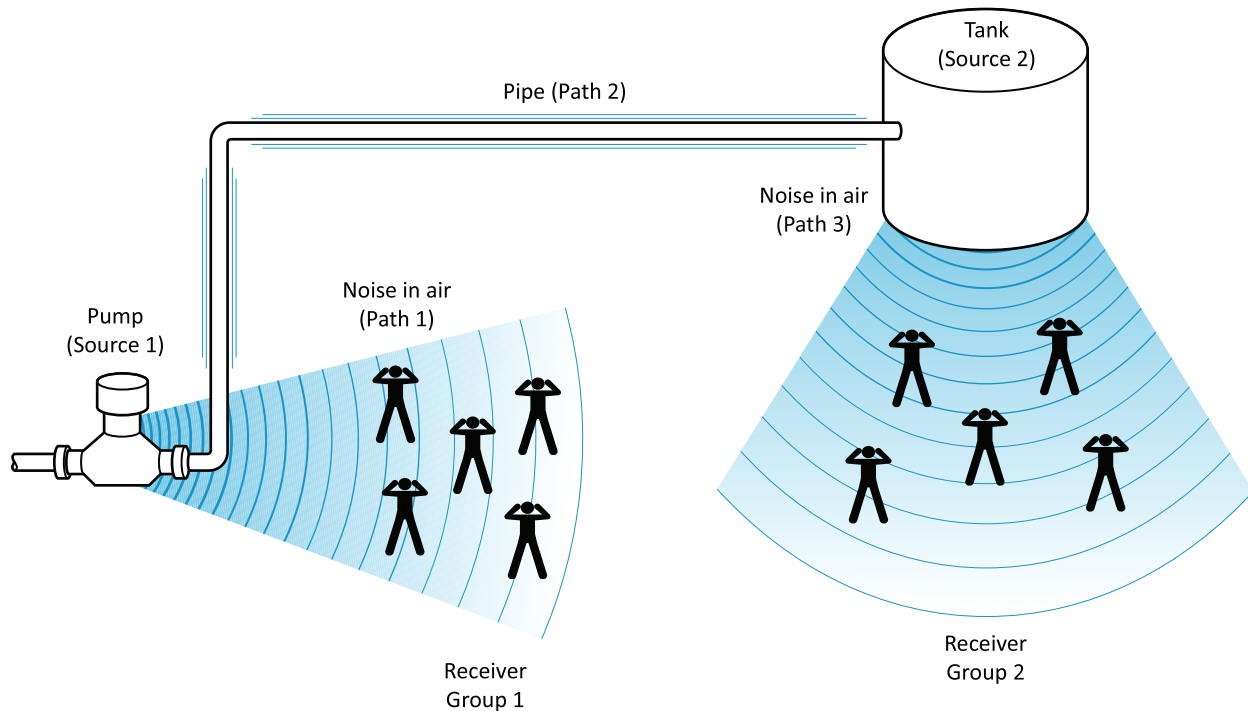
In consideration of the HLPP, the source of noise can come from many places; some examples might be the air handling system in a workplace, machinery used to manufacture products both to manipulate and/or modify the raw materials, as well as the conveying systems in a manufacturing location. Any manner of fans, pumps, valves, and machinery can make noise. All of these would be noise sources, in the “Source – Path – Receiver” model of thinking about the noise exposure situation.

The path for the noise normally takes one of a few forms — the noise can follow a path through the air from the source to the receiver. It can also follow mechanical paths through a structure, as well as through fluids in pipes and tanks, from the source location to the receiver location.

The receiver of the noise in this model of the energy flow is the individual worker and ultimately the ears of the worker — which the administrator is trying to protect from damaging noise levels.

Figure B.1 shows the source, path, and receiver elements for a simple pump (source 1) that generates noise and vibrations and fluid pulsations, with noise travelling to a group of workers (receiver group 1) through the air (path 1) as well as through some piping (path 2), and radiating from the walls of a tank (source 2) through the air (path 3) nearby to some other workers (receiver group 2).

Figure B.1
Diagram of sound propagation in a factory
 (See Clauses B.2 and B.4.)



B.3

Most administrators will be familiar with hearing protection devices (HPDs), whether they are various forms of earplugs, canal caps, or earmuffs. Use of HPDs attempts to control noise at the receiver location. Because there are usually multitudes of workers, this means that there are multitudes of receiver locations, and the mitigation of NIHL at these individual workers is always going to be a challenge. Hearing protectors should not be considered until all other practicable means have been exhausted.

B.4

While it might seem simple to put an enclosure around the noise source, this often does not solve the issue as there can be what are called “flanking paths”, such as the pipe in Figure B.1, where the pulsations of fluid noise and the vibration of the pump are being transmitted to the tank, which then radiates the noise as if it is a source in and of itself, and exposes an entirely different group of workers (receiver group 2) to hazardous noise. The solution is to purchase a quieter pump, which vibrates less and generates less flow pulsations. This would eliminate or reduce the noise exposure through path 1 to receiver group 1, as well as reduce the energy that is transmitted by the pipe to the tank and mitigate the exposure to receiver group 2.

B.5

There are many techniques the service provider hired to provide engineering controls will employ in their efforts to reduce the noise level in the facility to below the action level of 85 dBA. The following list illustrates some of them (see also AIHA’s *The Noise Manual* for guidance on strategies for other

control methods). The administrator is encouraged to delegate this process to professionals familiar with noise control engineering.

- a) All conduits and pipes leading to or from a machine should be laid in a trench up to the machine, or at least oriented to a single side of the machine. This allows a noise control enclosure to be installed or retrofitted without having to rework the plumbing and electrical connections.
- b) All vibrating equipment should be isolated from large radiating surfaces, including the floor. This might require vibration isolators plus flexible ducts, hoses, and electrical connections.
- c) All pneumatic, steam, or gas exhausts should be fed through a suitable silencer, taking care to avoid freezing or plugging.
- d) All air jets should include a blow-off silencer.
- e) Most fans require both inlet and exhaust silencers. Silencers should always be installed unless it can be shown that they are not necessary. It is good practice to leave sufficient space for a silencer, even if it is not installed initially.
- f) Silencers should be designed to handle the material in the gas stream, including moisture, dust, and abrasive and corrosive material, which might require that they be cleanable or have replaceable components. The casing should prevent breakout of the sound before it reaches the silencer.
- g) When specifying a motor sound level, an allowance should be included for the difference between laboratory measurements at no-load and the sound produced while under load. IEC 60034-9 gives typical allowances.
- h) Variable frequency drives can produce tones on the power supply of motors, which can cause them to produce audible tones. The drives should include adequate filtering to prevent this. IEC 60034-9 gives typical allowances.
- i) Metal-to-metal impacts should be cushioned whenever possible.
- j) Material should slide rather than drop, and where possible, chutes should be rubber-lined or externally damped.
- k) Large, noisy equipment (e.g., mills, generators, etc.) should be installed in a separate room that includes only equipment that will be turned off as a single system during a shutdown. This allows major maintenance to be carried out in a quiet environment without exposure to the noise from another similar line or an operating spare.
- l) Small rooms containing noisy equipment should be avoided if at all possible. If such a room is unavoidable, line it with sound-absorbing material such as mineral wool or fiberglass. As necessary, protect such material against moisture, oil, corrosive materials, and dust build-up, and against damage with an acoustically transparent outer facing, such as perforated metal. Such an assembly can be purchased as an acoustical panel. Such panels also form the basis of most noise enclosures. If possible, supply a separate noise enclosure for each piece of noisy equipment.
- m) It is better to buy quiet equipment than to enclose noisy equipment (see Clause 11.7). Enclosures provided with the equipment, e.g., compressors provided with their own noise enclosures, are generally better than site-built enclosures because the design work can be spread over a number of customers, and later customers benefit from the experience at multiple installations.
- n) All noise enclosures need to provide sufficient windows, lights, access points, doors, etc., to allow normal maintenance, including routine removal and replacement of panels. Sufficient ventilation should be provided to avoid excessive heat build-up.
- o) All gas valves should have their sound levels predicted, and quiet valves should be purchased when required.
- p) Noisy surfaces such as pipes, ducts, fan casings, etc., can be lagged to reduce noise. Ensure that easy access is allowed to inspection ports, flanges, etc., so that the lagging is not damaged or removed during routine maintenance. Once removed, it usually never goes back on.

Annex C (informative)

Best practices in hearing loss prevention

Notes:

- 1) *This Annex is not a mandatory part of this Standard.*
- 2) *The practices in this Annex are measures that go beyond the requirements in the main body of the Standard.*

C.1 HLPP effectiveness measures — Best practices

C.1.1 General

Reviewing audiometric tests as a measure of HLPP effectiveness exposes the worker to 2 to 3 years of possible ongoing hearing damage before it is detected. A better practice is to proactively periodically check the assumptions on which the HLPP is based, or upon any change to the assumed parameters, such as

- a) changes to the sources of noise either through building modifications, the addition of new equipment, alteration to manufacturing process, or the aging of the present equipment;
- b) restructuring of work shifts that changes the workers exposure to the noise;
- c) changes to the organization's standards for workplace safety based on a desire to reduce the incidence of NIHL; and
- d) reports from workers regarding difficulty in communicating, changes in noise levels, or difficulty in using their hearing protection.

When these triggers are detected, the HLPP's effectiveness can be compromised. The HLPP should document practices that are to take place when any of these triggers appear.

C.1.2 Noise measurements

Increasing the frequency of noise level measurements (such as doing them annually) can verify changes to existing noise exposure at a location over time. When changes to the structure housing the noise sources or the noise sources themselves change, new sound level measurements are to be taken.

C.1.3 Exposure measurements

When noise measurements show increased sound levels in certain areas of the facility, exposure measurements for those working in those areas should be updated.

C.1.4 Setting the appropriate action level

Under normal conditions, this Standard defines an action level of greater than 85 dBA for the commencement of the HLPP. However, in circumstances where hazardous noise exposure is combined with vibration and in the presence of some ototoxic elements, a lower action level is recommended for workers exposed to those conditions. In addition, refer to Clause 11.7 for reasons to set alternative action levels and what those action levels might be.

C.1.5 Hearing protection changes

When the noise exposure of workers in a workplace changes, the attenuation of their hearing protection might need to be modified. If noise exposure increases, the attenuation also needs to increase to compensate. A measure of exactly how much attenuation a worker is getting, done with an FAES, is beneficial in making this determination. Alternatively, ensuring the worker is well-trained in inserting and wearing their protection or providing double protection (see Clause 7.13) is advised.

Hearing protector attenuation needs to be matched to the noise exposure in order to encourage workers to keep the protectors in place. When noise exposure changes, the attenuation of the hearing protection the worker is using also needs to change to match it. Too little attenuation might cause the worker to be overexposed and suffer hearing damage. Too much attenuation might cause the worker to alter or disable their hearing protection, also leading to hearing damage. As these efforts are imprecise, they often lead to unintended overexposure and hearing damage.

C.1.6 Educating and training of workers

C.1.6.1 General

Worker education and training is a key to improved outcomes for the HLPP. This Standard mandates education at least every two years and training at least annually. Increasing the frequency and quality level of both the education and training will improve the ability of those workers to avoid NIHL. Increasing the frequency of the education component goes toward building the culture of worker responsibility (see Clause [C.1.8](#)). Moreover, providing additional training and different modes of training can be particularly useful in increasing and maintaining the worker's skill set.

C.1.6.2 Fitting earplugs

Training in fitting earplugs improves the attenuation the wearer gets from the earplugs. For earplugs, training is necessary in order to for the wearer to get a repeatable attenuation. Only when the wearer has mastered and can repeat the technique will he or she be effectively protected.

Care needs to be taken to instruct those wearing foam, pre-molded, and push-to-fit earplugs so that they achieve the correct fit. Wearers of custom-fit earplugs can also benefit from training, as can earmuff wearers. The administrator should ensure training in wearing the chosen type of hearing protection is a consistent part of the HLPP. Other training norms for best practices are as follows:

- a) Discuss training for fitting hearing protection in detail — individual training is more effective than group training.
- b) Use FAES in training workers to fit their HPDs, and give them feedback on their training and ability. There are FAES that allow workers to be tested with their hearing protection in place as they fit it. This provides direct feedback on their fitting capabilities.

C.1.6.3 Fitting earmuffs

The most important aspect of getting the appropriate attenuation from earmuffs is ensuring a firm, tight seal for the muff cup against the side of the head. The following graphs illustrate what happens to the attenuation when that seal is compromised.

Figure C.1
H7A earmuff compromised by
safety glasses temples
 (See Clause 7.4.9.)

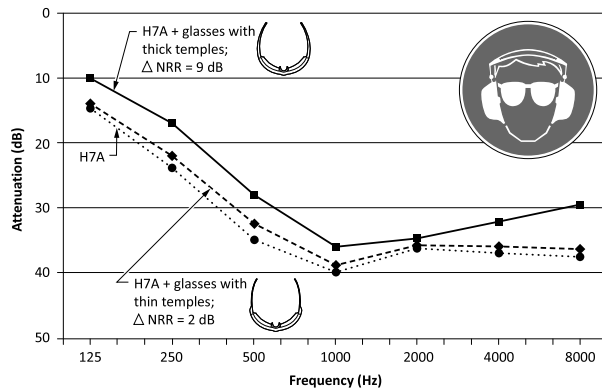
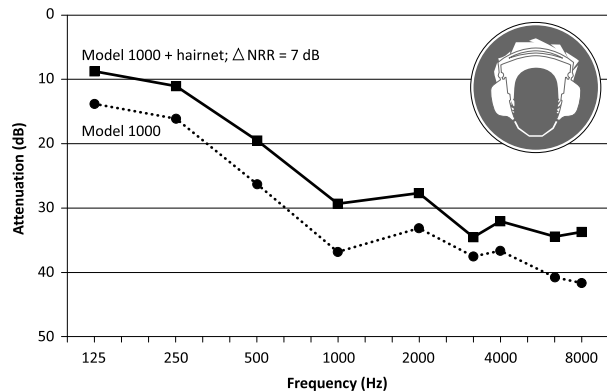


Figure C.2
Model 1000 earmuff compromised
by hairnet
 (See Clauses 7.4.9 and C.1.6.3.)



Note that in Figure C.2, compromising the seal of the muff can reduce the attenuation from 10 dB up to 50% of the attenuation of the earmuff. The administrator needs to do the hearing protection job compatibility analysis to ensure that those wearing muffs as their HPDs are not compromising the seal of the earmuff.

C.1.7 Conducting more frequent audiometric tests and lowering the threshold for audiometric test commencement

The audiometric test database is a predictor of future HLPP outcomes. The challenge is that for the database to be useful, it needs several series of tests to be predictive. More frequent testing of the hearing of workers with higher exposures is recommended.

To enhance the effectiveness of the program, that paradigm should be extended to all those exposed over $L_{EX,8}$ 100 dBA, or to workers with lower exposures where overexposure to ototoxic chemicals is possible. Also, it is good practice to begin offering audiometric testing for workers exposed to levels above 80 dBA $L_{EX,8}$ and to extend audiometric testing to all workers in the facility in order to develop an in-house non-noise-exposed group for comparison.

Note: Increasing the frequency of testing for these workers can create a useful database in less time.

C.1.8 Creating a culture of worker responsibility

Workers and management have a shared responsibility for the HLPP. Only from understanding and accepting that this responsibility is shared can a worker's hearing be adequately protected. The administrator should try to work consultatively with workers to get them to take ownership of and recommend changes to the HLPP; actions that management should facilitate.

C.1.9 Extending the HLPP culture outside of the workplace

The success of the HLPP depends, in part, on workers and management adopting a culture consistent with the aims of the HLPP. To facilitate that culture forming, the administrator should encourage the organization to extend the aims of the HLPP beyond the workplace. By supporting hearing safe practices away from work, the administrator can encourage those practices at work.

C.1.10 Inclusion of all workers in the HLPP

By involving everyone in the hearing loss prevention culture, by providing audiometric testing to everyone — noise-exposed and not, and by teaching the importance of hearing loss prevention to everyone, a norm of the facility will become hearing loss prevention. It will also provide an excellent baseline for evaluating the effectiveness of the HLPP. The administrator will be able to compare noise-exposed workers to those not exposed.

Annex D (informative)

Sample sound level map

Note: *This Annex is not a mandatory part of this Standard.*

Annex E (informative)

Risk assessment

Note: *This Annex is not a mandatory part of this Standard.*

E.1 Introduction

A number of noise reduction strategies should be considered, ranging from engineering controls that eliminate or reduce the hazard, to personal protective equipment to reduce the workers exposure. Strategies are selected for optimal results, based on a risk assessment.

Every risk assessment factor that can influence the outcome should be assessed based on a rationale, and every factor that can interact with another factor has a rationale to ultimately compute a risk rating.

The following factors can be considered when conducting a risk assessment for NIHL (other risk factors can be specific to the workplace):

- a) noise characteristics:
 - i) continuous;
 - ii) intermittent;
 - iii) impulse;
 - iv) reverberant;
 - v) duration (long term or short term);
 - vi) level (high or low);
 - vii) frequency (high or low); and
 - viii) directionality;
- b) noise source;
- c) environment characteristics (e.g., outdoors without noise reflection);
- d) building/room size;
- e) preventive maintenance:
 - i) lubrication;
 - ii) bearings; and
 - iii) cutting surfaces;
- f) condition of existing engineering controls:
 - i) vibration damping material (e.g., lining, constrained layering);
 - ii) sound absorbent material; and
 - iii) vibration isolators;
- g) equipment and material characteristics:
 - i) speed;
 - ii) maximum thickness;
 - iii) hardness;
 - iv) temperature; and
 - v) pressure;
- h) proximity to the noise source;
- i) directionality of the source respective of worker location;
- j) work practices;
- k) existence of standard operating procedures;
- l) vibration;
- m) exposure to ototoxic agents;

- n) training; and
- o) personal
 - i) genetic disposition;
 - ii) health factors;
 - iii) pre-employment contributing to hearing loss events;
 - iv) pre-existing hearing loss from previous employment;
 - v) exposure to ototoxic pharmaceuticals; and
 - vi) off-shift exposure of hobby/other job noise.

E.2 Proposed risk assessment

The following resources were reviewed for the development of this Annex:

- a) CAN/CSA-Z1002 — occupational health and safety (hazard identification and elimination and risk assessment and control);
- b) *The Noise Control Manual*, 5th Edition, Chapter 9, “Noise Control Engineering”; and
- c) information in CAN/CSA-Z94.4 (selection, use, and care of respirators).

E.3 Risk rating

E.3.1 Risk

A simple rating system can be used to assist in determining worker risk to noise. The manner in which this process is accomplished is dependent on the context, scope, and methods and techniques used to carry out the risk assessment. Individual health factors and pre-existing hearing loss have not been considered in this model. The risk rating, in this context, is being used to prioritize controls. At a minimum, two parameters should be obtained, as follows:

- a) noise exposure data for individuals, groups of individuals, or occupations as per the procedures specified in Z107.56; and
- b) relative severity of potential for hearing loss.

In the risk assessment below, it is advised to use the best data derived from noise exposure measurements, knowledge of the process, and number of workers conducting the task.

E.3.2 Severity

From the results of noise exposure level measurement for each group, the severity component of the equation could have the following categories:

- a) (L) Low = $L_{EX,8}$ of 85 to 88 dBA;
- b) (M) Medium = $L_{EX,8}$ of 89 to 94 dBA; and
- c) (H) High = $L_{EX,8}$ of > 95 dBA.

E.3.3 Hazard index

To prioritize risk, the number of workers exposed to noise levels should be considered. This can be converted to a hazard index in decibels by adding $10\log(\text{number of workers})$ to their mean noise exposure.

The following chart can be used to assist in developing the hazard index:

Number of workers	Mean $L_{EX,8}$ for group	Hazard index

Examples:

A plant with 150 workers has two operations of blanking metal pieces and grinding the pieces.

Job 1: 50 workers working 3 shifts on 15 blanking machines are exposed for 8 h to 95 dBA.

Number of workers	Mean $L_{EX,8}$ for group	Hazard index
50	95	$= 95 + 10\log(50)$ $= 95 + 17$ $= 112$

Job 2: 100 workers are grinding over three shifts with right angle grinders and exposed for 4 h to 90 dBA.

Number of workers	Mean $L_{EX,8}$ for group	Hazard index
100	87	$= 87 + 10\log(100)$ $= 87 + 20$ $= 107$

Using the hazard index, each job can be given a ranking. Those with highest ranking should be selected first for application of controls. In this example, Job 1 would be the priority.

For a more complex risk assessment methodology that incorporates cost, productivity, and the probability for success see *The Noise Control Manual*, published by the American Industrial Hygiene Association, "Noise Control Priority Factor" in Chapter 9 ("Noise Control Engineering"). Alternatively, it might be best to hire a consultant to provide this information.

Annex F (informative)

Canadian legislative context

Note: This Annex is not a mandatory part of this Standard.

F.1 General

The data in Table F.1 has been used with permission from the CCOHS (Canadian Centre for Occupational Health and Safety) (www.ccohs.ca).

Table F.1
Noise exposure limits in Canadian jurisdictions
(See Clause F.1.)

Jurisdiction (federal, provincial, territorial)	Continuous noise*		Impulse/Impact noise*	
	Maximum permitted exposure level for 8 h: dB(A)	Exchange rate dB(A)†	Maximum peak pressure level dB(peak)	Maximum number of impacts
Canada (federal)	87	3	—	—
British Columbia	85	3	140	—
Alberta	85	3	—	—
Saskatchewan	85	3	—	—
Manitoba	85	3	—	—
Ontario	85	3	—	—
Quebec	90	5	140	100
New Brunswick	85	3	140	—
Nova Scotia	85	3	—	—
Prince Edward Island	85	3	—	—
Newfoundland and Labrador	85	3	—	—
Northwest Territories	85	5	140	100
Nunavut	85	3 or 5‡	140	—
Yukon	85	3	140	90

* For more information about continuous, impulse, and impact noise, please see “Noise — Basic Information” (http://www.ccohs.ca/oshanswers/phys_agents/noise_basic.html).

† When a 3 dB exchange rate is used, generally there is no separate regulation for impulse/impact noise. The equivalent sound exposure level (L_{EX}) takes impulse noise into account in the same way as it does for continuous or intermittent noise.

‡ In Nunavut, the General Safety Regulations reference a 5 dB exchange rate. The Mining Health and Safety Regulations reference 3 dB. Please contact the Government of Nunavut for further information.

Noise regulations in several jurisdictions treat impulse noise separately from continuous noise. A common approach is to limit the number of impulses at a given peak pressure over a workday. In almost every case, the 85 dBA $L_{EX,8}$ limit will be exceeded before the impulse noise limit.

Alternatively, using a 3 dB exchange rate, impulse noise can be considered jointly with any continuous noise in measuring the overall L_{eq} sound level.

F.2 Noise exposure limits in Canadian legislation

Canada has 14 separate jurisdictions with differing regulations on the hearing protection matters addressed by this Standard. The objective of this Standard is to allow the disparate regulatory bodies to come together under one national Canadian Standard for the management of HLPPs. The following are references to the federal, provincial, and territorial legislation where the occupational noise exposure limits from the different jurisdictions in Canada can be found. Since legislation is amended from time to time, the jurisdiction should be contacted for the most current information about the noise exposure limits and how they are enforced. This information is intended as a guide only and might not apply to specific occupational sectors (e.g., mining). The regulations should also be consulted for information on requirements for hearing protection equipment and other control measures that might be prescribed for protecting the hearing of workers. The local office of the occupational health and safety agency for each jurisdiction should be contacted for specific questions that apply to a particular workplace.

Government of Canada

Canada Labour Code, Part II, (R.S.C. 1985, c. L-2)

Canada Occupational Safety and Health Regulations, (SOR/86-304)

Clause 7.4(1)(b)

British Columbia

Worker's Compensation Act

Occupational Health and Safety Regulations (BC Reg 296/97 as amended)

Clause 7.2 [B.C. Reg. 382/2004, s.1]

Alberta

Occupational Health and Safety Code, 2009

Clause 218; Table 1 of Schedule 3

Saskatchewan

Occupational Health and Safety Act, 1993 [R.R.S. c. 0-1.1, r.1]

Occupational Health and Safety Regulations, 1996

Part VIII, Clause 113(1)

Manitoba

Workplace Safety and Health Act [R.S.M. 1987, c. W210]

Workplace Safety and Health Regulation (Man. Reg. 217/2006) Part 12

Ontario

Occupational Health and Safety Act [R.S.O. 1990, c. 1]

Industrial Establishments (R.R.O. 1990, Reg 851)

Clause 139

Québec

Act Respecting Occupational Health and Safety [R.S.Q., c. 2.1]

Regulation respecting Occupational Health and Safety (O.C. 885-2001)

Division XV, Clauses 130 to 141

New Brunswick

Occupational Health and Safety Act

General Regulation (N.B Reg. 91-191 as amended)

Part V, Clauses 29 to 33

Nova Scotia

Workplace Health and Safety Regulations
N.S. Reg. 52/2013
Part 2, Clauses 2.1 to 2.3
(references ACGIH TLVs, as updated annually)

Prince Edward Island

Occupational Health and Safety Act
Occupational Health and Safety Act General Regulations (E.C. 180/87)
Part 8, Clause 8.3

Newfoundland and Labrador

Occupational Health and Safety Act
Occupational Health and Safety Regulations, 2012
Clause 68
(references ACGIH TLV, as updated annually)

Northwest Territories

Safety Act
General Safety Regulations (RRNWT 1990, c. S-1, R-028-93 as amended)
Clauses 30 and 31, Schedule A, Table 1

Nunavut

Safety Act
General Safety Regulations (RRNWT 1990, c. S-1)
Clauses 30 and 31, Schedule A
Mine Health and Safety Regulations, R-125-95
Clauses 9.19 to 9.26, Schedule 5

Yukon

Occupational Health and Safety Act
Occupational Health Regulation (O.I.C. 1986/164)
Clause 4

F.3 Managing an HLPP across multiple jurisdictions

Canada has 14 separate OHS regulatory jurisdictions with differing regulations for the various aspects of this Standard. It is the objective of this Standard to allow the recognition of one national Canadian Standard for the management of HLPPs. The following items detail some of the differences between jurisdictions:

- a) Noise exposure measurement — there is a wide range of approaches taken by various jurisdictions across Canada. Most (e.g., British Columbia, Alberta, Manitoba, Ontario, and the federal government) have adopted CAN/CSA-Z107.56-06 (R2011). Others have not, but often will accept its use.
- b) Québec refers to CSA Z107.2-1973, *Methods for the measurement of sound pressure levels*, which is a withdrawn standard (no longer maintained by CSA Group).
- c) New Brunswick only refers to an ANSI Standard for the sound level meter, and notes that the slow time weighting should be used, even for the peak pressure level, and provides its own formula for determining compliance given the sampling times.

- d) Nova Scotia and Newfoundland and Labrador refer to the limits in the ACGIH; it is not clear if there is any specification for measurement except via the ACGIH (American Conference of Industrial Hygienists).
- e) Northwest Territories, Nunavut, and Yukon general regulations do not refer to any measurement method.
- f) Nunavut mine regulations provide certain noise dosimeter specifications and specify that peak C or unweighted results should be used for impulse noise, but provide no other details and refer to no other Standard.
- g) Saskatchewan gives no detail on how to measure noise, but has considerable detail about reducing noise and monitoring hearing levels.
- h) Engineering controls — the Ontario, Quebec, British Columbia, and Alberta governments and CCOHS currently provide guidance on how to reduce workplace noise exposure using engineering controls. The supremacy of engineering controls, where technically and economically feasible, is indicated within most federal and provincial occupational noise legislation.

This list is by no means complete. There are many more discrepancies between jurisdictions and regulations lacking full definition. Implementation and citing in regulation of this management system Standard can provide a means to achieve improved HLPP outcomes.

Annex G (informative)

Unprotected exposures

Note: *This Annex is not a mandatory part of this Standard.*

G.1 Accounting for unprotected exposures

It is important to address the causes of unprotected exposures, through the following:

- a) Education — Teach workers about the effects of unprotected exposures, and how little it takes to affect their ears' ability to deal with noise the rest of their shift. Encourage them to seek quieter areas to have conversations.
- b) Using hearing protection devices that permit conversation — Many manufacturers have HPDs that enable conversation and communication in noise.
- c) Realizing that some unprotected exposure will take place, and designing the parameters of the HLPP to account for it — Reduce the level under-the-protector and shorten permitted exposures to the noise hazard to account for some unprotected exposures.
- d) Attenuation should be matched to the worker's noise exposure — This will mitigate their desire to disable their protection, causing an unprotected exposure.

Annex H (informative)

Comparison of and guidance for applying methods of estimating protected exposure

Note: *This Annex is not a mandatory part of this Standard.*

H.1 Using the class system

The noise exposure for each of the workers should be determined (see Clause 6). Once this noise exposure is known, the class of protector should be selected from Table 5, appropriate to the noise exposure. The class system is predicated on an $L_{EX,8}$ of 85 dBA.

Note: *The derating built into the class system, based on test results from ANSI S3.19, can be less than the derating determined when using the NRR derating protocol.*

H.2 Using NRR

The derated NRR can be used with either a noise level or noise exposure measurement. Derating the NRR is covered in Clause 7.10.5.2. A protector should be chosen with a derated NRR that achieves the protected value desired for the HLPP, using one of the following formulae depending on whether C-weighted or A-weighted values have been measured:

Protected exposure (dBA) = noise exposure (dBC) – derated NRR

or

Protected exposure (dBA) = noise exposure (dBA) – (derated NRR – 3)

See Table 4 for a more detailed explanation of NRR derating, use of the NRR, and application to situations when dual protection is being worn.

H.3 Using SNR(SF₈₄)

The SNR(SF₈₄) can be used directly with either a noise level or noise exposure. A protector should be chosen with an SNR(SF₈₄) that achieves the protected level desired for the HLPP, using one of the following formulae depending on whether C-weighted or A-weighted values have been measured (see Clause 7.12.3.3):

Protected exposure (dBA) = noise exposure (dBC) – SNR(SF₈₄)

or

Protected exposure (dBA) = noise exposure (dBA) – [SNR(SF₈₄) – 3]

H.4 Using octave band

Using this method requires octave-band noise levels or octave-band noise exposure. For instructions on use and derating of the octave-band method, see CSA Z94.2. The use of this method is beyond the scope of this Standard.

H.5 Using field attenuation estimation systems (FAES)

Use of FAES does not mean that the attenuation measurement and rating procedures described in Clauses 7.10.3, 7.10.4, and 7.10.5 are no longer applicable. Rather, FAES is intended to be used on an individual basis.

Using the fit-testing system or FAES, the workers' attenuation for the protectors they are wearing is measured and reported as a PAR (personal attenuation rating). The PAR reported by fit-testing systems is typically subtracted from the worker exposure level measured in dBA to estimate the protected level.

Table H.1
Methods of estimating protected exposure

Rating	Advantages	Disadvantages	Guidance
Class	Easy to use. Familiar from many years of standardization and use. Required by most Canadian provinces and territories.	Limited precision. Inappropriate class assignments might occur for HPDs with attenuation near the class boundaries.	Generally provides sufficient accuracy in most noises, however in noise with substantial low-frequency energy, noise sources with large variation in sound level from one frequency band to the next, or for greater precision choose one of the methods below.
NRR	Found on packages of all HPDs sold in Canada. Widely used and well known.	Overestimates attenuation for worker populations. Requires derating.	Only use the derated NRR as provided in Table 4.
SNR(SF₈₄)	Better estimate of field performance since it is based on ANSI/ASA S12.6 Method B data. Can be applied to either a Noise Level measurement or an Exposure measurement.	Not well known. Data not generally available. Data on which it is based can have higher variability test to test and between laboratories.	A potentially more accurate method to use when Method-B data are available.
Octave band	Potentially more accurate depending on HPD data that are utilized.	Not well known and seldom used. More difficult to implement. Requires octave-band noise measurements in the workplace.	Provides increased accuracy for exposures exceeding 95 dBA, noise sources with large variation from one frequency band to the next, and should be used for exposures greater than 105 dBA.
Fit testing	Applies to the individual worker. Does not require derating. Useful for training and motivation as well as estimating protection.	Adds time and costs to HLPP. Users might fail to understand that even with fit testing there is a degree of uncertainty in the measured values.	Preferred method of assigning HPDs based on noise exposure because it includes a training and motivational component to enhance user behavior.

Annex I (informative)

Brief summary of “Plan-Do-Check-Act” management theory

Note: *This Annex is not a mandatory part of this Standard.*

I.1 Overview

The “Plan-Do-Check-Act” approach achieves a balance between the systems and behavioural aspects of management. It also treats health and safety management as an integral part of good management generally, rather than as a stand-alone system.

I.2 Plan

This step includes the following:

- a) Think about where the HLPP is now and where it needs to be.
- b) State what is to be achieved, who will be responsible for what, how the aims will be achieved, and how success will be measured. This policy should be written along with plan to deliver it, and it should be reviewed annually.
- c) Decide how performance will be measured. Think about ways to do this that go beyond looking at accident figures — look for leading as well as lagging indicators, also called active and reactive indicators.
- d) Consider fire and other emergencies. Co-operate with anyone who shares the workplace and co-ordinate plans.
- e) Remember to plan for changes and identify any specific legal requirements that apply to this HLPP.

I.3 Do

This step includes the following:

- a) Identify the risk profiles.
- b) Assess the risks, identify what could cause harm in the workplace, who it could harm and how, and what can be done to manage the risk.
- c) Decide what the priorities are and identify the biggest risks.
- d) Organize the activities to deliver the plans.
- e) Involve workers and communicate, so that everyone is clear on what is needed and can discuss issues—develop positive attitudes and behaviours.
- f) Provide adequate resources, including competent advice where needed.
- g) Implement the plan.
- h) Decide on the preventive and protective measures needed and put them in place.
- i) Provide the right tools and equipment to do the job and keep them maintained.
- j) Train and instruct, to ensure everyone is competent to carry out their work.
- k) Supervise to make sure that arrangements are followed.

I.4 Check

This step includes the following:

- a) Measure the performance.
- b) Make sure that the plans have been implemented, “paperwork” on its own is not a good performance measure.

- c) Assess how well the risks are being controlled and if the aims are being achieved. In some circumstances, formal audits can be useful.
- d) Investigate the causes of accidents, incidents or near misses.

I.5 Act

This step includes the following:

- a) Review the performance.
- b) Learn from accidents and incidents, ill-health data, errors and relevant experience, including from other organizations.
- c) Revisit plans, policy documents and risk assessments to see if they need updating.
- d) Take action on lessons learned, including from audit and inspection reports.

Annex J (Informative)

Periodic assessment of HLPP performance

Note: This Annex is not a mandatory part of this Standard.

J.1 Suggested inspection and survey tables

As noted in Clause 11, periodic inspections are required to ensure changes in the characteristics of the workplace are reflected in changes to the HLPP. The following is a suggested checklist that the HLPP can use.

Visual inspection

Criteria	Yes	No	If no, recommended action or modification
All equipment appears to be operating normally compared to the last inspection.			
The condition of the existing noise controls is good and they are effective.			
All signs designating noise areas are in place and visible.			
Workers appear to be wearing their HPDs properly inserted and at all times when in hazardous noise areas.			
Controls, whether administrative or engineering, are in place and operating as designed.			

Worker interviews

Interviews with workers, supervisors, and management yielded the following information:

Question	Observations
Tell me about a change to production methods, equipment, operating conditions or hours of operation that might affect noise exposure.	
Have any changes in noise levels been noted? What are they?	
Have any of the noise controls failed to operate as usual?	
Have any of the HPDs being used interfered with other PPE or communication?	
Is the hearing protection being worn comfortable?	
Was training regarding noise and the potential for hearing loss provided and understood?	
Were the results of the most recent audiometric test results and recommendations provided in writing? (<i>Do not let them simply say that they know them.</i>)	

J.2 Noise level surveys

Periodically, these surveys need to be updated and reviewed. It is helpful to record the noise survey data on the same form so it can be compared to previous measurements.

Area of the facility	Date Noise survey result	Date Noise survey result	Date Noise survey result	Recommended action

J.3 Noise exposure measurements

Periodically, these measurements need to be updated and reviewed. It is helpful to record the noise measurement data on the same form so it can be compared to previous measurements.

Date of last measurements/ exposure	Area of the facility and noise source(s)	Individual or job measured	Activity	Contribution to total exposure	Date/current exposure	Recommended action
2015-08-12 101 dBA	Workshop	Joe — Welder	Grinding	98 dBA	2016-01-15 99 dBA	Investigate quieter grinders. Check clamping of material. Check adequacy of HPD.
2015-08-12 101 dBA	Workshop	Joe — Welder	Welding	90 dBA		

J.4 Additional measures

J.4.1 General

Clause 11 recommends additional measures that can be used to measure the effectiveness of the HLPP. Those measures are summarized in Clauses J.4.2 to J.4.4.

J.4.2 Review of audiometric test results

Provided confidentiality can be maintained, the results of audiometric tests should be reviewed to determine trends and compliance with the program. Anomalies and outliers should be identified.

J.4.3 Worker questionnaire responses

When personal interviews are unworkable, workers can be surveyed to give them the opportunity to critique the program.

J.4.4 Spot checks

J.4.4.1 Use of hearing protection

Periodic training on the use of their hearing protection should be done. If an FAES capable of measuring the occluded (HPDs in) condition is available, taking the worker or supervisor off the floor with the HPDs intact and measuring their personal attenuation rating (PAR) is a preferred training method. The table below can be used for this purpose.

If an FAES is not present or unavailable, periodic training should still be done. A record of the training, using the table below, should be kept.

Worker (name and position)	Dated trained	Best match protector	Comments

J.4.4.2 Verification of attenuation

If an FAES is available, the following testing should be considered:

Worker (name and position)	Dated tested	Protector tested	PAR achieved	Comments

Annex K (informative)

Explanation of dBA and dBC

Note: This Annex is not a mandatory part of this Standard.

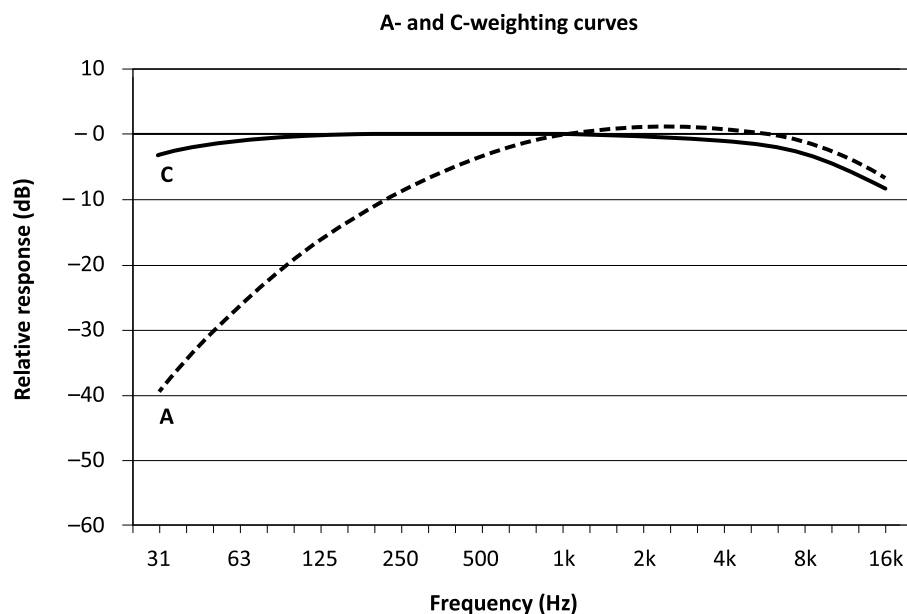
K.1

The letters “A” or “C” following the abbreviation “dB” designate how sound that is picked up by the microphone in the sound level meter is filtered. A filter function, also called a weighting characteristic (meaning that some frequencies are given more weight or importance than others), can also be thought of as a tone control. It emphasizes or de-emphasizes sounds of certain pitches relative to others. The actual influence of the A- and C-weighting functions is illustrated in Figure K.1. The vertical axis shows relative response in decibels, and the horizontal axis shows frequency measured in Hz or cycles/s (which is a measure of pitch).

K.2

The A-weighting filters out the low frequencies and slightly emphasizes the upper-middle frequencies around 2 to 3 kHz. It roughly approximates the sensitivity of human ears to moderate sound levels. By comparison, C-weighting is almost unweighted, that is it has almost no filtering at all. A-weighting is used to measure hearing risk and for compliance with regulations that specify permissible noise exposures in terms of a time-weighted average sound level or daily noise dose. C-weighting is used for computation of hearing protector attenuation with numbers like the noise reduction rating (NRR) or SNR (SF₈₄).

Figure K.1
Comparison of A and C sound measurement scales
(See Clause K.1.)



Annex L (informative)

Safety concerns for those workers with hearing loss

Note: *This Annex is not a mandatory part of this Standard.*

L.1 Overview

Workers with hearing loss might experience increased levels of risk due to the combined effects of their hearing loss and the attenuation characteristics of their HPDs. Though it is difficult to determine the extent to which hearing loss, ambient noise levels, and HPDs have contributed to workplace accidents, anecdotally there are many reports of injuries or fatalities caused by a worker's inability to hear backup alarms, warning signals, or shouts of warning from co-workers. As in all situations, employers are responsible for the safety of their workers, so they need to look at the specific work situation and functional hearing of the worker to assess whether a worker with hearing loss is able to work safely and pose no risk to themselves or others. Ultimately, the employer needs to determine whether accommodations are required to assist those with hearing loss within the HLPP, and in particular to determine that their safety will not be compromised by the addition of HPDs.

The assessment can be difficult, however, since pure-tone audiometric thresholds, which are the basis of audiometric testing, are not always reliable indicators of a worker's ability to perceive threats to safety. Pure-tone audiograms measure the ability to detect sound in each ear separately in a quiet environment, whereas a noisy job requires the ability to localize sounds (both ears are needed for this function) and to recognize and distinguish between critical sounds at supra-threshold levels (i.e., levels above just-detectable), all in the presence of hazardous background noise.

As a result, some employers (e.g., policing and piloting) have incorporated additional testing to supplement the pure-tone audiogram in their testing protocols. These tests include measurements of speech recognition in quiet and in noise, and sound localization. Such tests can help provide a more accurate picture of the worker's ability to detect warning signals and determine the source and location of safety risks.

L.2 Risk evaluation

When evaluating a worker's ability to function in a real-world work situation, often referred to as "functional hearing ability", the following criteria should be considered for assessment, and the results noted:

- a) Job communication requirements — A determination of the level of communication essential for the worker's job safety needs to be made. This should be based on the specific job duties performed by the worker. Policing and military positions, for example, often require higher standards than other, as the ability to hear critical commands and warnings can be more important.
- b) Workplace safety requirements — This refers to the level of hearing necessary at the work location to hear safety cues, such as the approach of moving vehicles like forklifts, back-up alarms from moving vehicles, warning bells or sirens, and audible cues for machine malfunctions. It is worth noting that unilateral hearing loss (i.e., loss in one ear) can negatively affect the ability to localize sound. Unfortunately, tests commonly used to assess localization ability are not readily available, and the equipment required (e.g., 12-speaker arrays) are not easily accessible.
- c) Use of HPDs — The use of passive hearing protection for a worker with pre-existing hearing loss can have the effect of artificially increasing that worker's hearing loss while the hearing protection is worn. This should be taken into consideration when assessing the workplace safety requirements. This consideration can lead to the selection of an active hearing protection device.

- d) Physical impairment — A complete medical and audiometric evaluation to determine the amount of hearing loss (if any) should be conducted. This typically includes a pure-tone audiogram, the standard measure of hearing loss, to determine the levels at which sound is detected in quiet. The physical assessment should also consider whether there is a medically treatable condition that is causing the hearing loss, and whether any physical condition precludes the proper use of hearing protection devices. If results from this testing indicate hearing within normal limits (typically defined as 20 dB HL or better), the worker is typically considered to be fit to safely perform their job duties.

Note: Here, the term “normal” refers to a norm for hearing that the organization needs to set. This norm needs to be set so that all workers determined to comply with the norm can hear warning sounds, alarms, and instructions from those around them when they are working. The organization should also be able to measure or have measured “normal” hearing.

- e) Functional impairment — This refers to the possible limitations a worker can experience in their job setting because of a hearing impairment. Functional areas include the ability to hear and interpret verbal cues, hear with background noise, hear warning signals, determine the direction of a sound source, and wear hearing protection and/or communication systems. “Functional exams” usually include speech-in-quiet and speech-in-noise tests, although there is no consensus on which speech tests are the most valid.

L.3 Mitigating the risk

The organization should consider all safety risks for each worker and make reasonable accommodations for workers. If workers appear to pose a threat to themselves or others as a result of their hearing loss, the organization should implement measures to eliminate the hazard or reduce the risk. This might require engineering controls to reduce noise levels, particularly if this can eliminate the need for HPDs. If this is not feasible, administrative controls should be considered (including restructuring job requirements, or altering job responsibilities or schedules). Assistive listening devices and visual alerting devices can also help accommodate those with hearing loss, and can mitigate risk.

L.4 Continued monitoring

Safety is an ongoing concern and should be continually monitored and assessed. Changes to the workplace should be assessed to determine if they will affect the HLPP in general, as well as whether the changes will compromise the safety of a worker with hearing loss. The following should be considered:

- a) New equipment or machinery or changes in the layout of a workplace — If new warning signals are introduced, these changes should be noted and workers should be able to detect and react to the signals. Where visual signals are necessary, they should remain visible to workers who rely upon them.
- b) Changes to the requirements for HPDs — If HPDs are required where they were not previously, or if HPDs with more attenuation are necessary, the effect on workers with hearing loss should be assessed. If necessary, engineering and administrative controls should be considered.
- c) Changes in a worker’s hearing — If a worker’s hearing changes such that he or she is no longer able to perform their job safely, administrative or engineering controls should be considered and implemented.

Workers should be encouraged to speak to management if they feel that their or someone else’s hearing impairment is compromising their safety. Management and the administrator should be aware of signs that hearing loss is impacting safety (e.g., workers tampering with their HPDs to reduce attenuation).

Annex M (informative)

Hearing protection job compatibility analysis

Note: *This Annex is not a mandatory part of this Standard.*

[illegible]

