10 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is something that all construction workers wear. It is designed to protect them from physical dangers and/or health hazards.

Equipment such as hard hats, safety glasses, and safety boots are designed to prevent an injury or reduce the severity of an injury if one occurs. Other PPE, such as hearing and respiratory protection, is designed to prevent illnesses and damage to the worker's health.

It is important to remember that PPE only provides protection. It reduces the risk but does not eliminate the hazard. The best way of protecting workers is to control the hazard at the source or along the path. However, if that is not possible, controls need to be put in place at the worker. This concept is referred to as the "hierarchy of controls" (Figure 10-1).

The chapters in this manual on different kinds of PPE (Chapters 10 to 17) will enable users to

- assess hazards and select a suitable control method
- locate and interpret legislation related to PPE
- effectively use and maintain PPE.

Legal Requirements

While common to all trades, PPE varies according to individual, job, and site conditions. Legal requirements for personal protective equipment also vary, so consult appropriate sections of the Construction Projects regulation (O. Reg. 213/91) under the *Occupational Health and Safety Act* (OHSA).

Employers have a duty under the OHSA to provide their workers with the PPE prescribed by law (OHSA, s.25(1)). Although many workers take their own PPE to a job, the employer is ultimately responsible for making sure that the proper PPE is used and is maintained in good condition.

Workers have a duty under the OHSA to wear or use PPE required by the employer (28.(1)(b)). In some situations, the regulations may not require PPE but the employer has set additional health and safety standards for the jobsite, such as mandatory eye protection.

The Construction Projects regulation (O. Reg. 213/91, s.21) requires that a worker wear such protective clothing and use such equipment or devices "as are necessary to protect the worker against the hazards to which the worker may be exposed." It also requires that the worker be trained in the use and care of this equipment.

Engineering Controls

When considering ways to defend against a workplace hazard, personal protective equipment (PPE) should be the last option. PPE is a way to control hazards **at the worker.** Better options are engineering controls that eliminate or reduce as much of the risk as possible **at the source** or **along the path** to the worker (Figure 10-1).

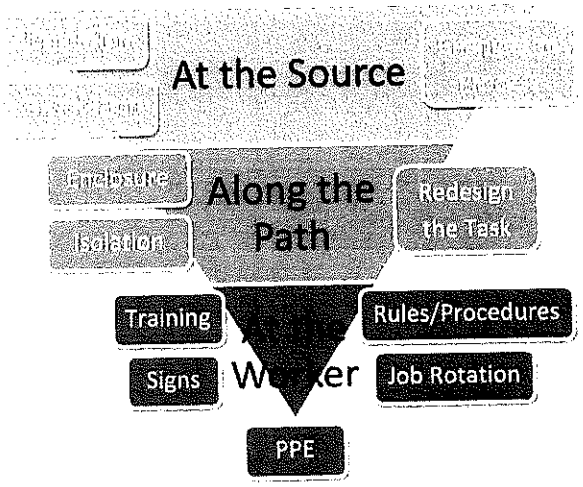


Figure 10-1: Hierarchy of Controls

Engineering controls fall into five categories:

1. Substitution
2. Alternative work methods
3. Isolation
4. Enclosure
5. Ventilation.

Substitution

Use a safer method or material that can do the same job (e.g., a less toxic chemical). A common example is the substitution of calcium silicate or fibreglass insulation for asbestos insulation.

Alternative Work Methods

Find another way to do the job in a way that is less hazardous. For example, brushing or rolling paint produces much lower vapour levels than spray painting. Similarly, wetting asbestos-containing material before removal releases up to 100 times less dust than dry removal. Make sure to check that the new work method is safer.

Isolation

Isolate the worker from the hazard. In a quarry, for example, the operator of a crusher can be isolated from dust by a filtered, air-conditioned cab.

Enclosure

Enclose a substance or procedure to contain toxic emissions. It may be as simple as putting a lid on an open solvent tank or enclosing an asbestos-removal project with polyethylene sheeting (Figure 10-2). Enclosures have also been built around compressors to reduce the noise level. Make sure they do not restrict access when maintenance is required.

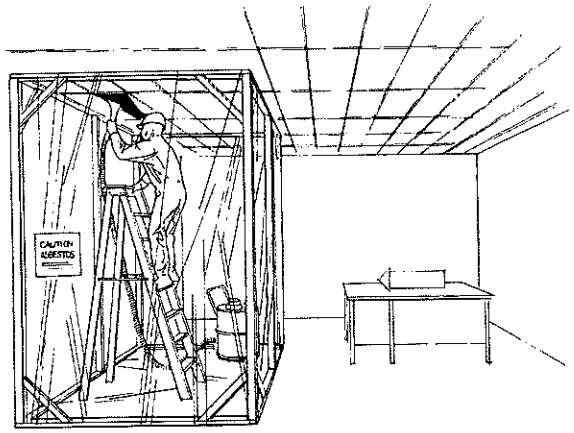


Figure 10-2: Enclosure

Ventilation

Control the amount of contaminant in the air by using ventilation. Local ventilation is better because it removes the contaminant. General ventilation dilutes the amount of contaminant by using large fans to move large volumes of air and increase air exchange. This method is not suitable for highly toxic materials.

Local ventilation captures and removes contaminants at their source. At a shop bench, a fume hood can be constructed to remove dusts and fumes. On sites, portable fume extractors (Figure 10-3) can be used. Remember: many filtering systems can only remove fumes—not gases or vapours.

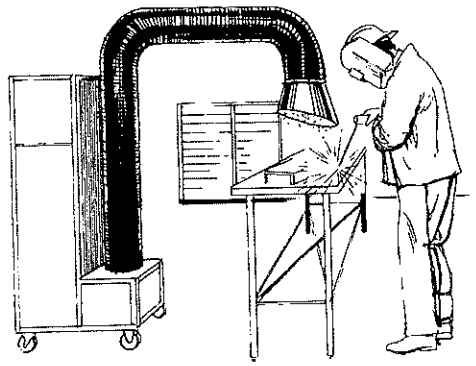


Figure 10-3: Fume Extractor

Personal Protective Equipment

When it is not possible to apply any of the five engineering controls, personal protective equipment may be the only option.

Regulations often refer to the Canadian Standards Association (CSA) or other equipment standards to identify equipment that meets the legal requirements and is acceptable. CSA-certified equipment can be identified by the CSA logo (Figure 10-4).

Figure 10-4: CSA Logo

There are CSA standards for different kinds of personal protective equipment such as these:

- Head Protection – CSA Z94.1-15
- Eye Protection – CSA Z94.3-15 and Z94.3.1-16
- Foot Protection – CSA Z195-14 and Z195.1-16

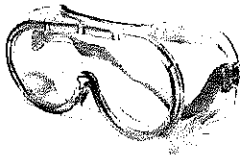
For respiratory protection, National Institute for Occupational Safety and Health (NIOSH) standards and approvals are usually referenced throughout North America.

For life jackets, Transport Canada certification is the standard reference.

You'll find information on specific types of PPE in the next few chapters.

11 EYE PROTECTION

Proper eye protection can reduce the risk of an eye injury. However, eye protection is not the whole answer. Knowing the hazards, using the proper tools, and establishing safe work procedures is also very important.



Like any other manufactured product, eye protection has material, engineering, and design limitations. But selecting the proper eye protection to match the specific construction hazard can help reduce the number and severity of eye injuries.

Considering that one out of every two construction workers may suffer a serious eye injury during their career, the importance of wearing proper eye protection cannot be overemphasized. In the hazardous environment of the construction industry, wearing proper eye protection on a jobsite should be a mandatory policy, not just a recommended practice.

Classes of Eye Protectors

Before outlining the type(s) of eye protectors recommended for a particular work hazard, it is necessary to explain the various types available. Eye protectors are designed to provide protection against three types of hazards:

1. Impact
2. Splash
3. Radiation (visible and invisible light rays).

For the purposes of this manual, they are grouped into seven classifications based on the CSA Standard Z94.3-15: *Eye and Face Protectors.*

Class 1 – Spectacles

Class 2 – Goggles

Class 3 – Welding Helmets

Class 4 – Welding Hand Shields

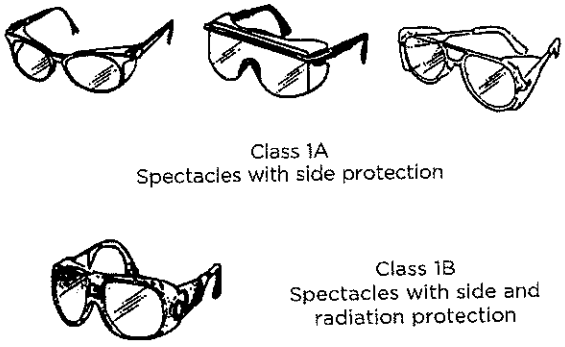
Class 5 – Hoods

Class 6 – Face Shields

Class 7 – Respirator Facepieces.

Spectacles (Class 1 Eye Protection)

CSA Standard Z94.3-15 requires that Class 1 spectacles incorporate side protection. Most side shields are permanently attached to the eyewear, but some may be detachable (Figure 11-1).



Class 1A
Spectacles with side protection

Class 1B
Spectacles with side and radiation protection

Figure 11-1: Types of Class 1 Eye Protection

Goggles (Class 2 Eye Protection)

There are two types of goggles:

1. Eyecup goggles
2. Cover goggles.

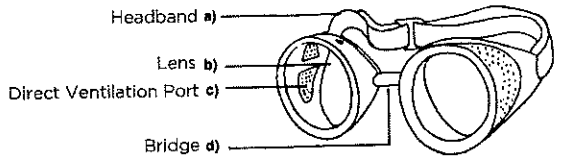
Both must meet the CAN/CSA Z94.3-15.

Eyecup goggles (Figure 11-2) completely cover the eye socket to give all-round protection. They have adjustable or elasticized headbands and are equipped with ventilation ports to allow air in and prevent fogging.

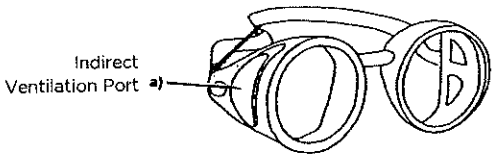
Some have direct ventilation ports that prevent large particles from getting through but do not keep out dust or liquids. Others have indirect ventilation ports that keep out large particles, dust, and liquids. There are also models available with an adjustable chain bridge.

Cover goggles (Figure 11-3) are designed to be worn over spectacles. Like eyecup goggles, they have adjustable or elasticized headbands and are equipped with direct or indirect ventilation ports to allow air in and prevent fogging.

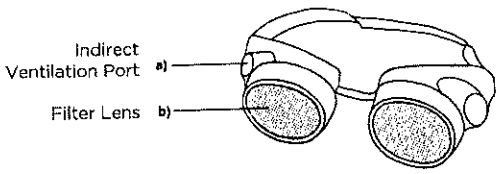
While both models keep out large particles, indirect-vented goggles are better at keeping out liquids and dusts.



Class 2A – Direct ventilated goggles for impact protection

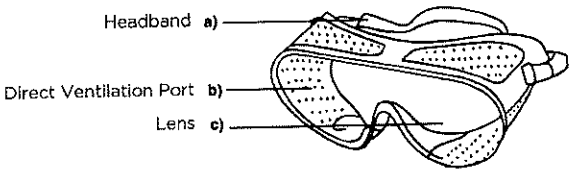


Class 2B – Non-ventilated and indirect ventilated goggles for impact, dust, and splash protection

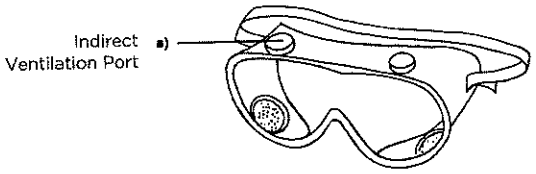


Class 2C – Radiation protection with filter lenses to exclude light

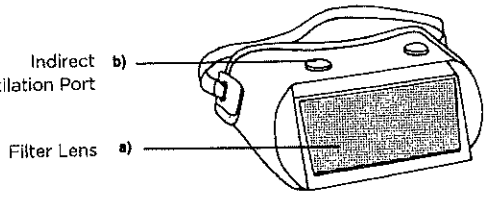
Figure 11-2: Eyecup Goggles



Class 2A – Direct ventilated goggles for impact protection



Class 2B – Non-ventilated and indirect ventilated goggles for impact, dust, and splash protection



Class 2C – Radiation protection with filter lenses to exclude light

Figure 11-3 Cover Goggles

Welding Helmets (Class 3 Eye Protection)

Class 3 eye protection provides radiation and impact protection for the face and eyes. There are two types of welding helmets available:

1. Stationary plate helmet
2. Lift-front or flipup plate helmet (Figure 11-4).

Lift-front helmets or shields have three plates or lenses:

1. A filter or shaded plate made of glass or plastic in the flip-up cover
2. A clear thin glass or plastic outer lens to keep it clean
3. A clear, impact-resistant plastic or glass lens mounted in the helmet itself.

Stationary plate helmets are similar to lift-front helmets except for the fact that they have a single filter lens plate, normally 51 mm x 108 mm (2 in x 4.25 in) in size, or a larger plate 114 mm x 113 mm (4.5 in x 5.25 in) in size, which is more suitable for those who wear spectacles.

There are also special models incorporating earmuff sound arrestors and air purification systems. Special magnifying lens plates manufactured to fixed powers are available for workers requiring corrective keep together.

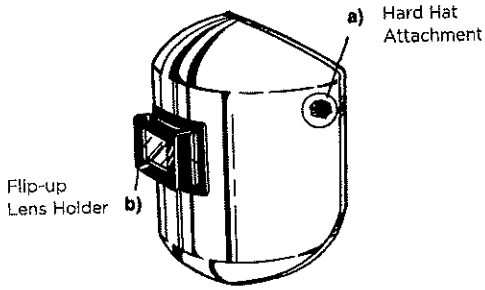


Figure 11-4: Welding Helmet

The filter or shaded plate is the radiation barrier. Arc welding produces both visible light intensity and invisible ultraviolet and infrared radiation. These ultraviolet rays are the same type of invisible rays that cause skin burning and eye damage from overexposure to the sun. However, ultraviolet rays from arc welding are considerably more severe because the eyes are close to the arc and the rays are not absorbed by ozone in the atmosphere.

In arc welding, therefore, it is necessary to use a filter plate of the proper lens shade number to act as a barrier to these dangerous light rays and to reduce them to the required safe degree of intensity. For proper welding shade numbers, see Table 11-1.

In addition to common green filters, many special filters are also available. Some improve visibility by reducing yellow or red flare; others make the colour judgment of temperature easier. A special gold coating on the filter lens provides additional protection by reflecting radiation.

Welding Hand Shields (Class 4 Eye Protection)

Welding hand shields are similar to Class 3 welding helmets except that there are no lift-front type models. They are designed to give radiation and impact protection for the face and eyes (Figure 11-5).

NOTE: With welding helmets and hand shields, the user is continually lifting and lowering the visor. To protect the eyes when the visor is lifted, Class 1 spectacles should be worn underneath.

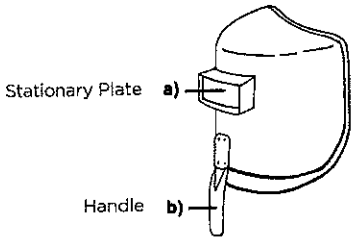


Figure 11-5: Welding Hand Shields

Hoods (Class 5 Eye Protection)

Non-rigid helmets or hoods come with impact-resistant windows usually made of plastic. An air-supply system may also be incorporated. Hoods may be made of non-rigid material for use in confined spaces and of collapsible construction for convenience in carrying and storing (Figure 11-6).

The different types include:

- 5A - Hoods with impact-resistant window
- 5B - Hoods for dust, splash, and abrasive materials protection
- 5C - Hoods with radiation protection
- 5D - Hoods for high-heat applications.

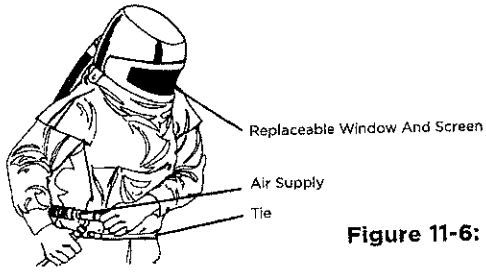


Figure 11-6: Hoods

Face Shields (Class 6 Eye Protection)

Face shields have a transparent window or visor to shield the face and eyes from impact, splash, heat, or glare. With face shields, as with welding helmets and hand shields, the user is continually lifting and lowering the visor. To protect the eyes when the visor is lifted, wear Class 1 spectacles underneath.

Face shields may come with an adjustable spark deflector or brow guard that fits on the worker's hard hat. Shaded windows are also available to provide glare reduction. However, these do not meet the requirements of CSA Z94.3-15 *Eye and Face Protectors* for ultraviolet and total heat, so should not be used in situations where any hazard is present from UV or infrared radiation.

The different types are shown below (Figure 11-7):

- 6A - Face shields for impact, piercing, splash, head, and glare protection
- 6B - Face shields for radiation protection. Similar to 6A but with a thicker shield. Also for low heat, splash, glare, and light, non-piercing impact protection
- 6C - Face shields for high-heat applications and light, non-piercing impact protection only (usually has wire screen windows).

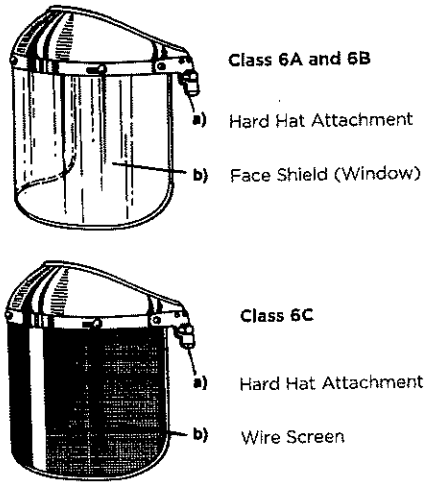


Figure 11-7: Face Shields

Respirator Facepieces (Class 7 Eye Protection)

For more information about respirator facepieces, refer to Chapter 15: Respiratory Protection. The different types are shown below (Figure 11-8):

- 7A - Respirator facepieces for impact and splash protection
- 7B - Respirator facepieces for radiation protection
- 7C - Respirator facepieces with loose-fitting hoods or helmets
- 7D - Respirator facepieces with loose-fitting hoods or helmets for radiation protection.

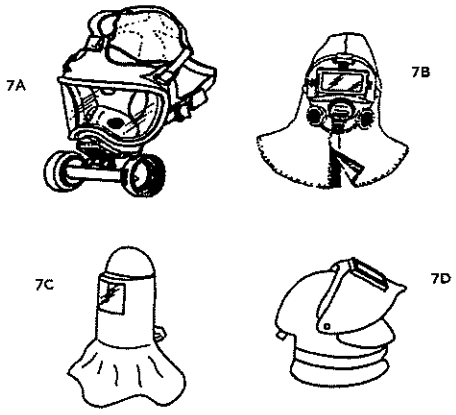


Figure 11-8: Respirator Facepieces

Table 11-1: Recommended Shade Numbers for Arc Welding and Cutting

Operation	Current in amperes (0.5 1.0 2.5 5.0 10 15 20 30 40 60 80 100 125 150 175 200 225 250 275 300 350 400 450 500)
SMAW (covered electrodes)	7 | 8 | 10 | 11
GMAW (MIG)	7 | 10 | 10 | 10
GTAW (TIG)	8 | 8 | 10
Air carbon arc cutting	10
Plasma arc cutting	8 | 9 | 10
Plasma arc welding	6 | 8 | 10 | 11

Courtesy Canadian Standards Association

Notes:

(1) For other welding processes (e.g., laser, electron beam welding), consult the manufacturer for eye protection recommendations.

(2) For pulsed GMAW (MIG), use peak current for selecting the appropriate shade number.

(3) For underwater welding, the minimum shade number shown may not necessarily apply.

Recommended Eye Protectors

Table 11-2, which has been reprinted from CSA Standard Z94.3-15: *Eye and Face Protectors,* classifies the main eye hazards and outlines the types of protectors recommended for each. Each situation requires that all hazards be considered in selecting the appropriate protector or combination of protectors.

It is strongly recommended that employers require all construction personnel to wear Class 1 eye protection (spectacles). Spectacles should also be worn underneath Classes 3, 4, 5, 6, or 7 eye protectors if they're needed to prevent a hazard.

The following classifications provide a general overview of eye protectors for each hazard group. For specific hazards, refer to Table 11-2 at the end of this chapter. Note that the best eye protection results from a combination of different classes of eye protectors.

Group A: Flying Objects (Figure 11-9)

Minimum eye protection recommended:

Class 1 spectacles

Optimum eye protection recommended:

Goggles worn with face shields to provide eye and face protection.

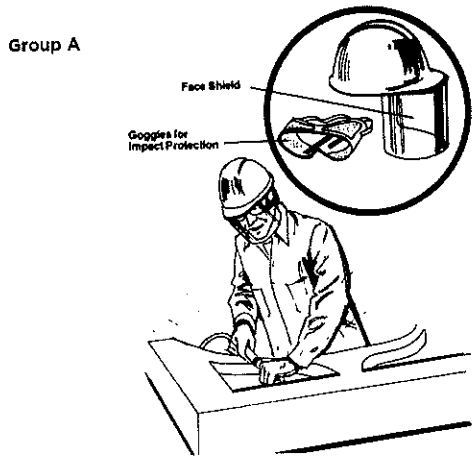


Figure 11-9: Protection from Flying Objects (Chipping)

Group B: Flying Particles, Dust, Wind, etc. (Figure 11-10)

Minimum eye protection recommended:
Class 1 spectacles

Optimum eye protection recommended:
Goggles (for dust and splash) worn with face shields to provide eye and face protection.

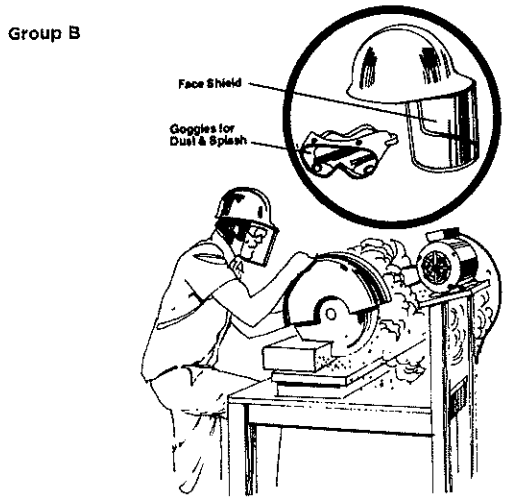


Figure 11-10: Protection from Flying Particles, Dust, Wind (Sawing)

Group C: Heat, Glare, Sparks, and Splash from Molten Metal (Figure 11-11)

Minimum eye protection recommended:
Class 1 spectacles with filter lenses for radiation protection. Side shields must have filtering capability equal to or greater than the front lenses.

Optimum eye protection recommended:
Eyecup or cover goggles with filter lenses for radiation protection, worn with face shields to provide eye and face protection.

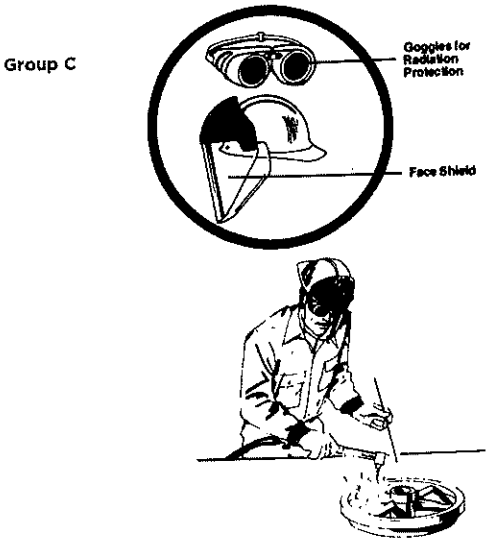


Figure 11-11: Protection from Heat, Glare, Sparks, and Splash (Brazing)

Group D: Acid Splash, Chemical Burns, etc. (Figure 11-12)

Only eye protection recommended:
Eyecup or cover goggles (for dust and splash) worn with face shields to provide eye and face protection.

Hoods may also be required for certain hazardous activities such as chemical spraying.

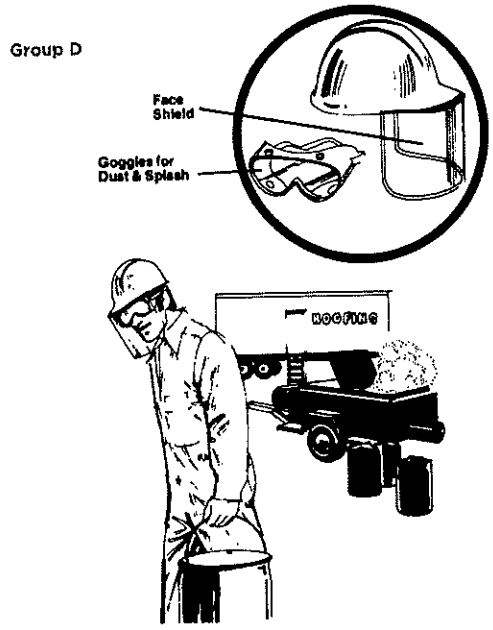


Figure 11-12: Protection from Acid Splash, Chemical Burns, etc. (Roofing)

Group E: Abrasive Blasting Materials (Figure 11-13)

Minimum eye protection recommended:
Eyecup or cover goggles for dust and splash.

Optimum eye protection recommended:
Hoods with an air line.

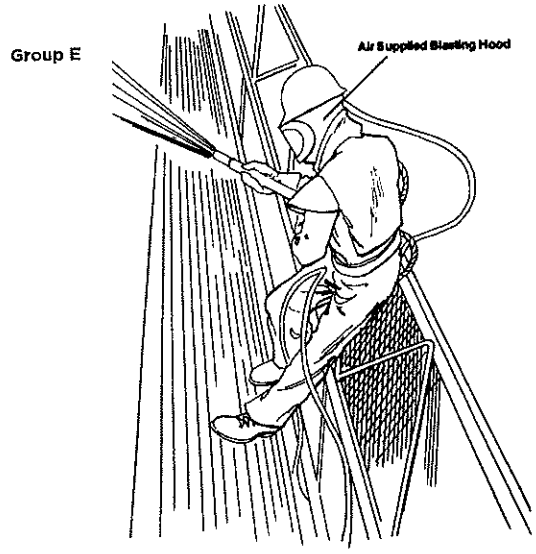


Figure 11-13: Protection from Abrasive Blasting

Group F: Glare, Stray Light (Figure 11-14)

These are situations where only slight reduction of visible light is required (e.g., against reflected welding flash). Stray light would result from passing by a welding operation and receiving a flash from the side without looking directly at the operation.

Minimum eye protection recommended:
Filter lenses for radiation protection. Side shields must have filtering capability equal to or greater than the front lenses.

Optimum eye protection recommended:
Goggles with filter lenses for radiation protection. See Table 11-1 for recommended shade numbers.

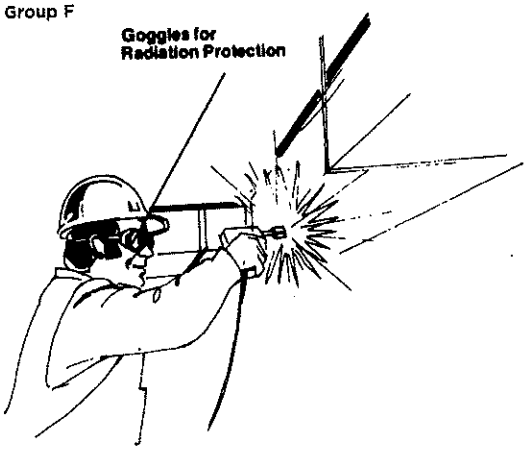


Figure 11-14: Protection from Glare, Stray Light

Group G: Injurious Radiation (Glass Cutting) (Figure 11-15)

These are situations where only moderate reduction of visible light is required (e. g., gas welding). Injurious radiation would result from looking directly at the welding operation.

Only eye protection recommended:
Goggles with filter lenses for radiation protection.

Note: The intensity of the flame and arc is lower in Group G than in Group H. For this reason, the filter shade numbers required for this group are also lower (See Table 11-1).

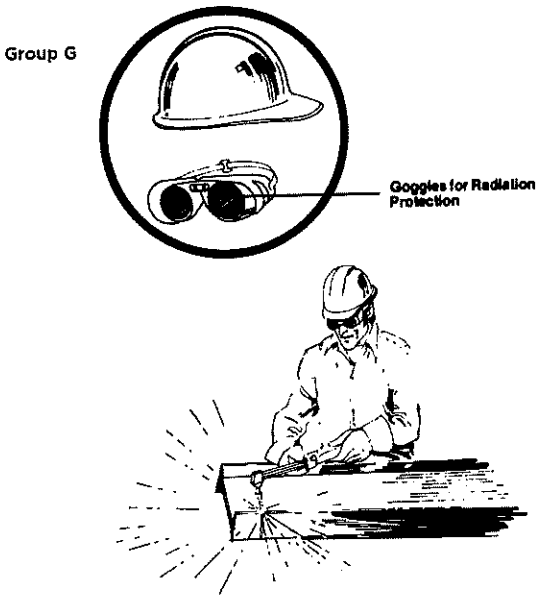


Figure 11-15: Protection from Injurious Radiation (Gas Cutting)

Group H: Injurious Radiation (Electric Arc Welding) (Figure 11-16)

These are situations where a large reduction in visible light is essential (e.g., in electric arc welding).

Only eye protection recommended:
Class 1 spectacles worn with full welding helmets or welding hand shields. These spectacles should incorporate suitable filter lenses if additional protection is required when the welding helmet is in the raised position (e.g., when working near other welding operations). See Table 11-1.

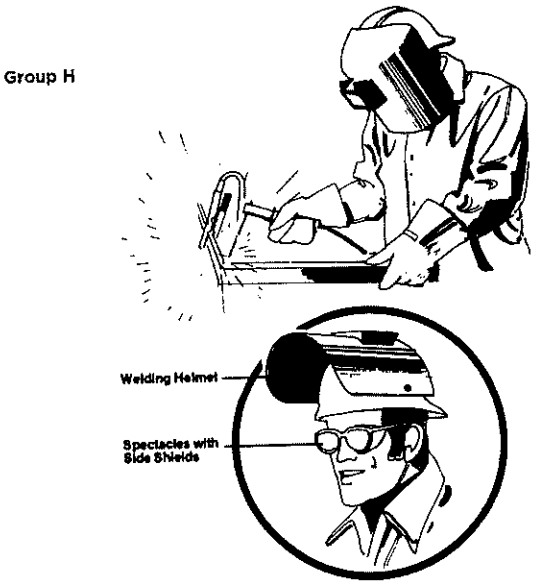


Figure 11-16: Protection from Injurious Radiation (Electric Arc Welding)

Common Construction Hazards

The cornea is the front layer of the eye and the first point where light enters. If light rays cannot pass through the cornea, vision is prevented. The construction hazards listed below can cause scarring, scratching, or inflammation to the cornea, which can impair sight.

1. **Flying Objects**
   A piece of metal can pierce the cornea and eyeball and possibly cause the loss of an eye.
2. **Dust**
   Dust, sawdust, etc. can cause irritation resulting in a corneal ulcer, which is a breakdown of corneal tissue causing the eye to become red, watery, or full of pus.
3. **Heat**
   Heat can burn and severely damage the cornea.
4. **Acid Splash**
   Acid splash and chemicals can burn the cornea, the conjunctiva (white coat on the eye), and the eyelid, possibly causing a loss of sight.
5. **Abrasive**
   Sand can cause a corneal abrasion, which can result in loss of sight.
6. **Glare**
   Glare can make it difficult to see and can cause extreme fatigue to the eye.
7. **Radiation**
   Ultraviolet light from a welding arc can damage the cornea.

Proper eye protection, when matched to the hazard, can prevent or reduce the severity of any eye injury. If one occurs, however, it is critical that it be given immediate attention and first aid, even if it's a minor injury.

Eye protection can only protect against injury if it is worn continuously on site. An eye injury often occurs when a worker removes the eye protection while working near or passing by other hazardous activities on the job. When it is necessary to remove eye protection, do it in a location that is completely away from hazardous work areas. The inconvenience of wearing eye protection is far outweighed by the risk of being blinded in one or both eyes.

Choosing Protective Spectacles

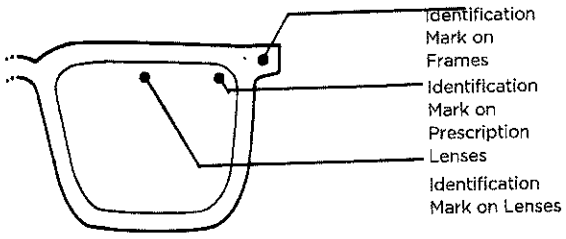
Protective spectacles are available with "plano" or non-prescription lenses as well as with prescription ones.

The polycarbonate materials used in safety glasses provide the best protection, while regular plastic CR-39 lenses in industrial thickness provide a substitute where polycarbonate is not available. Anti-scratch coatings are applied to the lens surface to extend useful lens life.

Glass lenses, even when thermally or chemically hardened, are not acceptable for the workplace. They do not meet the impact requirements of CSA Standard Z94.3-15.

When purchasing safety glasses, specify "industrial protection" lenses and frames. This term indicates that the eye protection meets specific test requirements.

Industrial protection safety glasses can be identified by the manufacturer's or supplier's logo or monogram, which is located on the lens and frame (Figure 11-17). This mark must appear on both the frame **and** the lens. It distinguishes industrial quality lenses and frames from streetwear lenses and frames.



Look for the CSA logo on non-prescription eye protectors

Figure 11-17: Locating Identification Marks or Symbols

The Canadian Standards Association (CSA) certification program for non-prescription (plano) industrial eye and face protection covers complete protectors only. It does not cover separate components such as lenses, frames, or shields.

In addition to the manufacturer's logo or I.D. mark that appears on the eye protector, the CSA logo will appear to indicate that the eye protection meets the requirements of the CSA Z94.3-15 standard. Certification of industrial prescription safety glasses is not yet available.

Until such a program is available, the user should look for the manufacturer's or supplier's logo or I.D. mark on the frame and lens. This shows that it meets the American National Standards Institute (ANSI) Standard Z87.1-1989.

Proper Fit

Improper fit is the most common reason why workers resist wearing eye protection. A worker who wears non-prescription (plano) lenses and continues to complain about blurred vision after the fit has been checked by a competent person may require prescription lenses. Prescription lenses must be fitted by an optician or optometrist. Plano eye protection should be fitted individually by a trained person.

Here are some general guidelines to follow when fitting the various classes of eye protectors.

Class 1 – Spectacles require that the proper eye size, bridge size, and temple length be measured for each individual. The wearer should be able to lower his head without the spectacles slipping.

Class 2 – Goggles with adjustable headbands should fit snugly over the wearer's spectacles when worn.

Class 3 – Welding helmets are equipped with adjustable attachments to provide a comfortable fit over the head and face. Attachments are also available to fit on hard hats.

Class 4 – Hand-held shields require no adjustment.

Class 5 – Hoods can be adjusted at the top inside part of the hood. A tie is located around the neck to secure the hood and to prevent the entry of dust.

Class 6 – Face shields are equipped with adjustable attachments to provide a comfortable fit over the head and face. Attachments are also available to fit on hard hats.

Class 7 – Respirator facepieces should fit snugly without gaps to make an effective seal against airborne contaminants.

Proper Care

Eye protectors in construction are subjected to many damage-causing hazards. Like all equipment, eye protection must be cared for and inspected to make sure it works properly.

- Inspect lenses regularly for pitting and scratches, which can make it difficult to see clearly.
- Repair scratched or pitted lenses and loose frames or arms as soon as possible or replace them with parts from the original manufacturer.
- Clean the lenses with clear water to remove abrasive dust. Cleaning lenses when they are dry can scratch the surface.
- Anti-fog solutions can be used on glass or plastic lenses.
- Handle frames with care and check daily for cracks and scratches.
- Never throw eye protectors into tool boxes where they can become scratched or damaged.
- Cases should be provided and used to protect spectacle lenses when they are not being worn.

Contact Lenses

In the construction industry, contact lenses are not a substitute for protective eyewear. Dust and dirt can get behind the contact lenses causing sudden discomfort and making it hard to see.

Contact lenses are also difficult to keep clean when they have to be removed or inserted since suitable washing-up facilities are not often available on a jobsite.

It is recommended that contact lenses **not** be worn on construction sites. However, if they must be worn to correct an eye defect, the worker should get written permission from an ophthalmologist or optometrist indicating why wearing contact lenses is needed in order to work safely. In these cases, eye protection—preferably cover goggles— must be worn with the contact lenses.

Table 11-2: Hazards and Recommended Protectors

Hazard groups	Nature of hazard	Hazardous activities involving but not limited to	Spectacles Class 1		Goggles Class 2			Welding helmet Class 3	Welding hand shield Class 4	Face shields Class 6			Non-rigid hoods Class 5			
			A	B	A	B	C			A	B	C	A	B	C	D
A	Flying objects	Chipping, scaling, stonework, drilling; grinding, buffing, polishing, etc.; hammer mills, crushing; heavy sawing, planing; wire and strip handling; hammering, unpacking, nailing; punch press, lathework, etc.	■		■	■				■			■	■		
B	Flying particles, dust, wind, etc.	Woodworking, sanding; light metal working and machining; exposure to dust and wind; resistance welding (no radiation exposure); sand, cement, aggregate handling; painting; concrete work, plastering; material batching and mixing	■		■	■				■			■	■		
C	Heat, sparks, and splash from molten materials	Babbiting, casting, pouring molten metal; brazing, soldering; spot welding, stud welding; hot dipping operations		■			■				■	■			■	■
D	Acid splash; chemical burns	Acid and alkali handling; degreasing, pickling and plating operations; glass breakage; chemical spray; liquid bitumen handling				■				■				■		
E	Abrasive blasting materials	Sand blasting; shot blasting; shotcreting				■				■				■		
F	Glare, stray light (where reduction of visible radiation is required)	Reflection, bright sun and lights; reflected welding flash; photographic copying	■		■	■				■				■		
G	Injurious optical radiation (where moderate reduction of optical radiation is required)	Torch cutting, welding, brazing, furnace work; metal pouring, spot welding, photographic copying		■			■				■				■	
H	Injurious optical radiation (where large reduction of optical radiation is required)	Electric arc welding; heavy gas cutting; plasma spraying and cutting; inert gas shielded arc welding; atomic hydrogen welding						■	■							

Source: Canadian Standards Association

NOTE: **Shaded areas are recommendations for protectors.** Class 1 and Class 2 protectors shall be used in conjunction with recommendations for Class 3, 4, 5, and 6 protectors. The possibility of multiple and simultaneous exposure to a variety of hazards shall be considered in assessing the needed protection. Adequate protection against the highest level of each of the hazards should be provided. This Table cannot encompass all of the various hazards that may be encountered. In each particular situation, thorough consideration should be given to the severity of all the hazards in selecting the appropriate protector or combination of protectors. The practice of wearing protective spectacles (Class 1B) with filter lenses under welding helmets or hand shields is strongly recommended to ensure impact and flash protection to the wearer when the helmet or lift front is raised or the shield is not in use. Protectors that meet the requirements for ignition and flame resistance are not intended to provide protection in environments that expose the user to open flames or high-energy arcs.

12 HEAD PROTECTION

Requirements for head protection are specified in section 22 of the Construction Projects regulation (O. Reg. 213/91).

Under this regulation, hard hats are mandatory for every worker at all times on a construction project in Ontario. The hard hat must protect the wearer's head against impact and against small flying or falling objects. It must be able to withstand an electrical contact equal to 20,000 volts phase-to-ground.

Standards

Hard hats that meet the minimum criteria established by the Canadian Standards Association (CSA) and the American National Standards (ANSI) are:

CSA

- Z94.1-05: Class E, Type 1
- Z94.1-05: Class E, Type 2
- Z94.1-1992: Class E

ANSI

- ANSI Z89.1-2009: Class E, Type I
- ANSI Z89.1-2009: Class E, Type II
- ANSI Z89.1-2003: Class E, Type I
- ANSI Z89.1-2003: Class E, Type II

Labels and Markings

The "Type" and "Class" of hard hat can be identified by the CSA or ANSI label. Some manufacturers also stamp the CSA or ANSI classification into the shell of the hard hat under the brim (Figure 12-1).

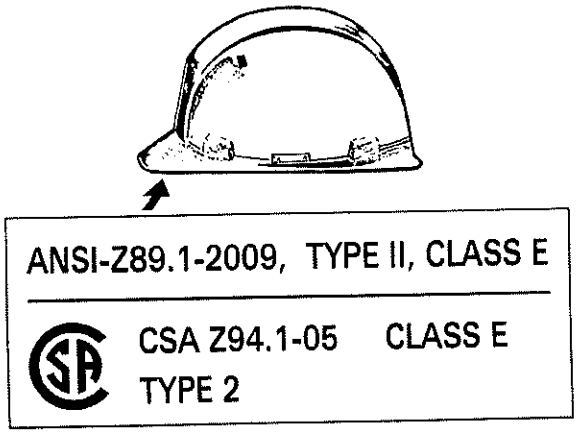
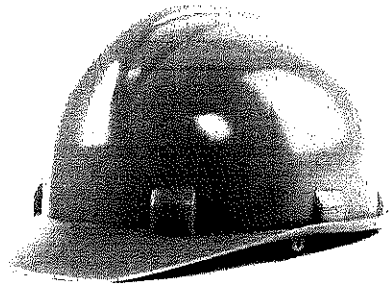


Figure 12-1: Type 2 Class E Hard Hat



Although both Type 1 and Type 2 hard hats protect the top of the head, Type 2 hard hats provide extra protection against side impact and penetration. That's why a Type 2 hard hat is recommended for construction work.

Hard hats that comply with the CSA and ANSI standards must contain other information marked inside the hard hat such as:

- Manufacturer's identity
- Model
- Class and type (e.g. Class E, Type 2)
- Reverse orientation mark if applicable
- Year and month of manufacture
- Size or size range
- The following wording,

  This protective headwear is designed to absorb some of the energy of a blow through destruction of its component parts and, even though damage may not be apparent, any partial protective headwear subjected to severe impact should be replaced.

  This protective headwear must not be painted or cleaned with solvents. Any decals applied to the protective headwear must be compatible with the surface material and known not to affect adversely the characteristics of the materials used in the protective headwear.

  Any addition or structural modification may reduce the protective properties afforded by this protective headwear.

Styles

Class E hard hats come in three basic styles:

1. Standard design with a front brim, rain gutter, and attachment points for accessories such as hearing protection
2. Standard design with a front brim and attachment points for accessories, but without a rain gutter
3. Full-brim design with attachment points for accessories and a brim that extends completely around the hat for greater protection from the sun (Figure 12-2).

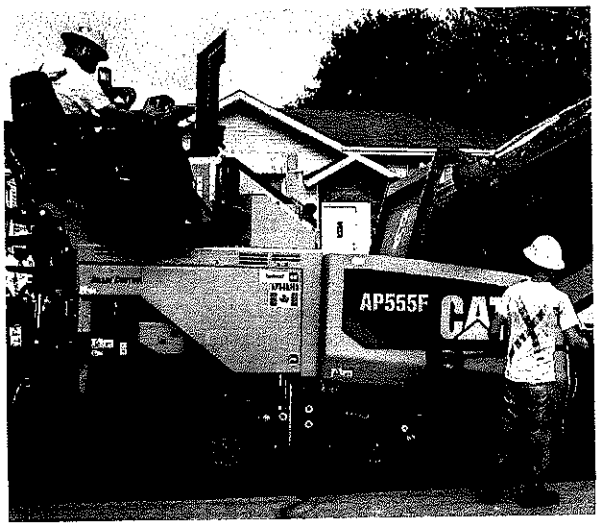


Figure 12-2: Full-brim Hard Hats Provide Extra Protection Against the Sun

Reversible Hard Hats

You should normally wear your hard hat facing forward. A hard hat should be worn in reverse only if

1. The hard hat has a reverse orientation mark (Figure 12-3).
2. The job, task, or work environment necessitates wearing it backward (e.g., when wearing a face shield or welding helmet).

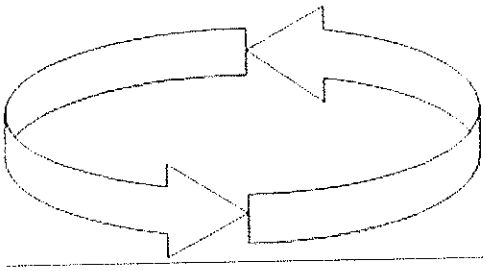


Figure 12-3: Reverse Orientation Mark

Use and Care

Always consult the manufacturer's instructions for use and care instructions of your hard hat. You may also need to know which components of the hard hat must be inspected before each use.

- Inspect the shell, suspension, and liner every day before you use it. Look for cracks, dents, cuts, or gouges. Replace damaged or worn hats and liners immediately.
- If a hard hat is struck by an object, do not keep using it.
- Don't store your hard hat in direct sunlight—it will age quicker and can become brittle.
- Clean the shell, suspension, and liner regularly with mild soap and water.
- Never alter your hard hat by painting it, making holes in it, etc.
- Don't carry things inside your hard hat.
- Don't wear a baseball cap under your hard hat.
- Use a hard hat with a chinstrap when working at heights or in windy conditions.
- Check the service life of your hard hat by contacting the manufacturer or reading the manufacturer's instructions.
- Putting retroreflective stickers or tape on a hard hat can help workers be seen by moving vehicles and equipment in conditions where visibility is reduced. However, the stickers or tape must be compatible with the surface material, not adversely affect the material, and not interfere with the ability to inspect the hard hat for defects. Place them at least 13 mm (1/2 in) above the edge of the brim.

13 FOOT PROTECTION

Section 23 of the Construction Projects regulation (213/91) requires that all workers must wear protective footwear at all times when on a project. Protective footwear is a safety shoe or safety boot with the following features:

- A box toe that is adequate to protect the wearer's toes against injury due to impact and is capable of resisting at least 125 joules impact
- A sole or insole that is adequate to protect the wearer's feet against injury due to puncture and is capable of resisting a penetration load of 1.2 kilonewtons when tested with a Deutsche Industrie Norm standard pin.

When worn properly, a CSA-certified Grade 1 workboot meets the requirements of the regulation.

Grade 1 Workboots

One of three CSA grades, Grade 1 offers the highest protection and is the only one allowed in construction. In a Grade 1 boot, a steel toe protects against falling objects, while a steel insole prevents punctures to the bottom of the foot.

Grade 1 boots can be identified by the following markings (Figure 13-1):

- A green triangular patch containing the CSA logo on the outside of the boot
- A green label indicating Grade 1 protection on the inside of the boot

Figure 13-1: Grade 1 Safety Boot with CSA Label

Grade 1 boots are also available with metatarsal and dielectric protection. A white label with the Greek letter Omega in orange means that the boot protects against electric shock under dry conditions (Figure 13-2).

Greek Omega Label

Figure 13-2: Indicates Electric Shock Resistance

Selection and Fit

Grade 1 boots are available in various styles and sole materials for different types of work. For example, Grade 1 rubber boots may be better suited than leather boots for sewer and watermain or concrete work.

Boots should provide ample "toe room" (toes about 1/2 inch back from the front of steel box toe cap when standing with boots laced).

When fitting boots, allow for heavy work socks. If extra sock liners or special arch supports are to be worn in the boots, insert these when fitting boots.

Care and Use

Lacing boots military style allows them to be removed faster. In an emergency, the surface lace points can be cut, quickly releasing the boot.

In winter, keep feet warm by wearing a pair of light socks covered by a pair of wool socks. Feet should be checked periodically for frostbite.

The majority of foot injuries in Ontario construction are ankle injuries. To help prevent these injuries, use high-cut (260 mm or 9 in) or medium-cut (150 mm or 6 in) CSA Grade 1 workboots. The higher cut helps support the ankle and provides protection from cuts or punctures to the ankle.

Clean your workboots regularly and check them for damage and wear and tear. Defective or worn out footwear will no longer protect your feet properly and must be replaced.

14 HEARING PROTECTION

Many construction tasks produce noise. Typical construction work may involve equipment driven by large and small engines, metal fabrication, power drilling and sawing, air hammering, and blasting—all of which can produce noise at harmful levels.

Depending on the noise level, duration of exposure, and other factors, a temporary or permanent hearing loss may result. Temporary hearing loss will usually be restored by the body within a few hours after the exposure has stopped. Hearing loss that cannot be restored by the body over any length of time is termed permanent.

Noise Exposure Hazards

Over time, exposure to noise can cause the following problems:

- Noise-induced hearing loss (NIHL)
- Tinnitus (ringing in the ears)
- High blood pressure
- Fatigue.

Noise-induced hearing loss is the most common occupational disease suffered by construction workers in Ontario. It often happens gradually, so workers may not realize that loud noise from their job is damaging their hearing. By the time they do realize it, it's too late—the damage is permanent and can't be reversed. That's why protecting the hearing of workers must be part of a company's health and safety program.

New Noise Regulation

A new regulation on Noise (O. Reg. 381) came into effect in 2016. It requires employers to protect workers from overexposure to noise. It sets out a time-weighted average limit of 85 dBA of noise exposure over an 8-hour shift (dBA stands for decibels, which is a unit that measures the intensity of sound).

If workers are exposed to levels above 85 dBA, the employer must consider using engineering and administrative controls to reduce noise at the source or along the path to the worker.

If it is not possible to control noise at the source or along the path, the employer can consider using personal protective equipment (PPE) such as hearing protection devices (HPDs) to control noise at the worker. However, as specified in the Noise regulation, the employer must select the proper HPDs based on the jobsite conditions and must provide adequate training and instruction on the HPDs workers will be using.

Noise Measurement

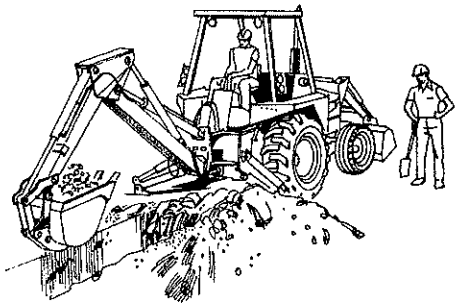
Measuring sound levels can determine the following:

- Whether or not the noise is a risk to workers' hearing
- The amount of noise workers are exposed to
- Where to focus controls to minimize the level of noise exposure.

Measurements are performed with a sound level meter (SLM). The unit used to measure the intensity of sound is the decibel (dB). Intensity is perceived as loudness.

Noise levels can't be added directly like other numbers. For example, two noise sources producing 90 dB each would have a combined output of 93 dB, not 180 dB. The combined output of 93 dB is actually a *doubling* of intensity.

In many construction situations, several different sources each contribute to the overall noise. This means that a worker's exposure may be much higher than it would be if only one of the sources were present (Figure 14-1).



If a backhoe produces 90 dB of noise, the worker standing nearby is exposed to 90 dB.

If a backhoe and a compressor each produce 90 dB of noise, the worker standing between them is exposed to 93 dB, which is double the amount of noise intensity.

Figure 14-1: Noise Levels from Multiple Sources

In addition to intensity, the SLM can detect a wide range of frequencies. Since the human ear tends to filter out the lower frequencies and slightly accentuate the higher ones, SLMs are engineered to do the same. They feature an internal mechanism called "A-weighting." The resulting noise level is expressed as decibels (dB) on the "A" scale or dBA.

Two types of noise measurements can be performed:

1. Area noise measurements
2. Personal noise measurements.

Area noise measurement is taken in a specific work area. It's generally a preliminary step to determine whether more detailed evaluation involving personal noise measurement is necessary. Area noise readings should not be used to determine what hearing protection is required or who needs a hearing test. Use personal noise measurement for that purpose.

Personal noise measurement involves a small device called a noise dosimeter. Workers can wear the device to determine their average noise exposure over a whole shift. The dosimeter has a microphone that is placed as close to the worker's ear as possible.

Noise measurements should be carried out in accordance with acceptable standards. Canadian Standards Association (CSA) Standard Z107.56: *Measurement of Noise Exposure* provides guidance on the type of equipment to use, which workers to test, and how to test.

Noise evaluation must be done by a knowledgeable person who has been trained and experienced in conducting noise surveys.

Hearing Process

The hearing process begins when the outer ear directs sound waves into the ear canal (Figure 14-2). The eardrum vibrates as sound waves strike it. This vibration is then transmitted through the middle ear where it is amplified on a membrane called the oval window.

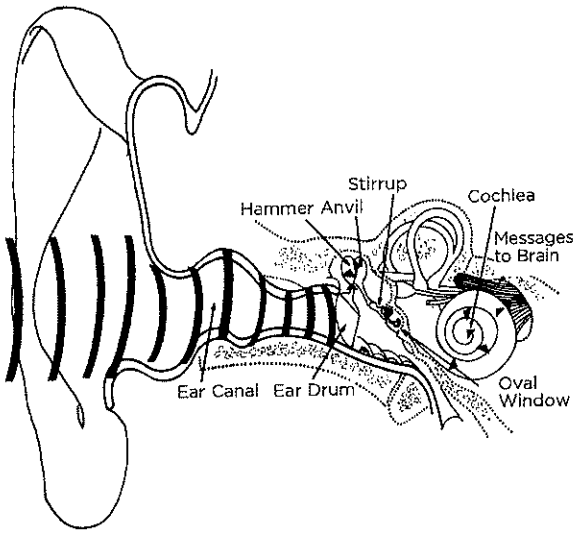


Figure 14-2: Sound Travelling Through the Ear Canal

The oval window separates the middle ear from the inner ear where the sensitive hearing organs are located. Attached to the other side of the oval window is a tiny, snail-shaped structure called the cochlea. The cochlea contains fluid and hair cells. These thousands of small but highly sensitive hair cells feel the vibration. Responding to the cells are microscopic nerve endings that send messages to the brain, where the signals are interpreted as varieties of sound.

Hearing Loss

Any reduction in the normal ability to hear is referred to as a loss of hearing. A hearing loss can be either temporary or permanent.

Temporary Threshold Shift

With a temporary hearing loss, normal hearing will usually return after a rest period away from all sources of intense or loud noise. The recovery period may be minutes, hours, a day, or perhaps even longer. It is believed that a temporary hearing loss occurs when hair cells in the inner ear have been bent by vibrations and need time to bounce back.

Most of the temporary hearing loss occurs during the first two hours of exposure. Recovery usually takes place within the first two hours after exposure stops. However, the length of time needed for recovery depends primarily on how great the initial loss was. The greater the initial loss, the longer the time needed to recuperate. This temporary decrease in hearing ability is called a temporary threshold shift (TTS) because the threshold or level at which sound can be heard has been raised.

For instance, to listen to your favourite music at the volume you like, you would have to turn it up a few more notches than usual. This phenomenon explains why some people, particularly those who suffer from some form of hearing loss, claim that they "get used to the noise."

If these previous exposures are allowed to continue under the same conditions and without the proper interval of rest, then a certain degree of permanent hearing loss is possible.

Permanent Threshold Shift

Permanent hearing loss is the result of hair cell or nerve destruction within the cochlea. Once these important parts of the hearing process are destroyed, they can never be restored or regenerated. The resulting permanent hearing loss, also referred to as permanent threshold shift (PTS), can range from slight impairment to nearly total deafness.

A symptom of PTS is the inability to pick up sounds with higher frequencies. As damage increases, the reception of speech becomes more difficult.

Unfortunately, the damage builds up gradually. Workers may not notice changes from one day to another. But once the damage is done there is no cure.

Look for the following signs that hearing loss may be occurring:

- Having difficulty telling similar-sounding words apart or picking out a voice in a crowd (Sounds and speech have become muffled.)
- Asking people to speak up, then complaining that they are shouting
- Experiencing a permanent ringing in the ears (tinnitus)
- Turning the volume on the radio or television up very high
- Difficulty hearing a person on the telephone.

Determining Factors

The following factors determine the degree and extent of hearing loss:

- **Type of Noise**
  (i.e., continuous, intermittent, impact, high or low frequency)
- **Intensity of Noise**
  (i.e., level of loudness)
- **Duration of Exposure**
  (length of time worker subjected to noise—during the day, on specific shifts, etc.)
- **Employment Duration**
  (i.e., years worker subjected to noise)
- **Type of Noise Environment**
  (character of surroundings—enclosed, open, reflective surfaces, etc.)
- **Source Distance(s)**
  (i.e., distance of worker from noise source)
- **Worker's Position**
  (i.e., position of worker relative to noise source)
- **Worker's Age**
  (e.g., a 20-year-old apprentice versus a 50-year-old journeyperson)
- **Individual Susceptibility**
  (e.g., degree of sensitivity, physical impairments)
- **Worker's Present Health**
  (i.e., whether a worker has any detectable hearing loss or ear diseases)
- **Worker's Home and Leisure Activities**
  (exposures to noise outside the workplace, such as hunting, skeet shooting, earphone music, snowmobiling, wearing earphones, listening to loud music, etc.)

Other prime causes of permanent hearing loss are age, traumatic injuries (such as from explosions or gunfire), and infection. Noise, however, is the major identifiable cause of hearing loss.

Hearing Protection Devices

Hearing protection devices (HPDs) should only be provided when engineering and administrative controls to reduce noise at the source or along the path cannot be implemented or while such controls are being put in place.

HPDs are barriers that reduce the amount of noise reaching the sensitive inner ear. Fit, comfort, and sound reduction or "attenuation" are important considerations in choosing HPDs.

The types of HPDs used most commonly are earplugs or earmuffs. Earplugs attenuate noise by plugging the ear canal. Earmuffs cover the external part of the ear, providing an "acoustical seal" (Figure 14-3). Table 14-1 describes some of the characteristics of these different types of hearing protectors.

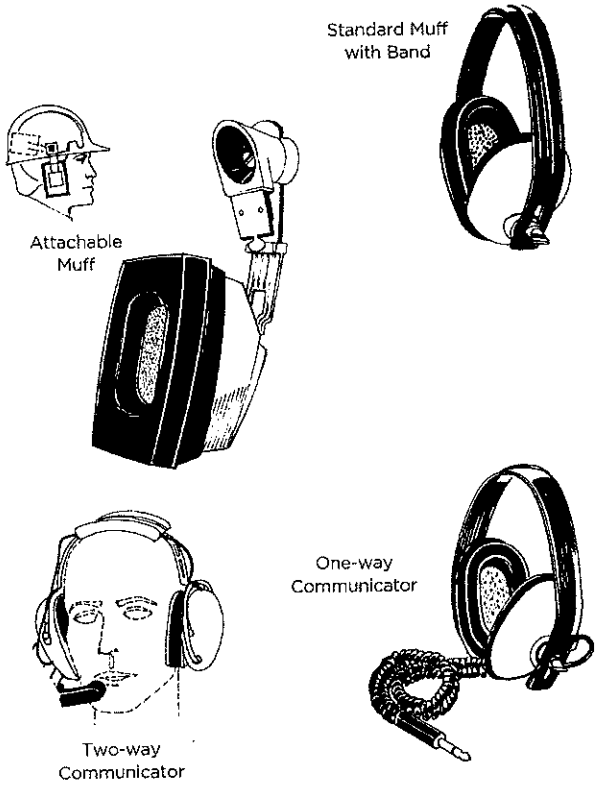
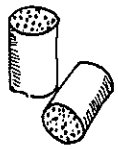
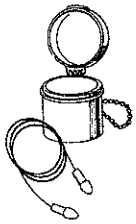
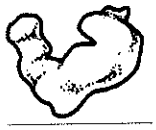


Figure 14-3: Types of Earmuffs

Table 14-1: Types of Hearing Protection Devices

	FOAM EARPLUGS	PREMOULDED EARPLUGS	EARMUFFS	FORMABLE EARPLUGS	CUSTOM-MOULDED EARPLUGS	SEMI-INSERT EARPLUGS
						
STYLE and COMFORT	Made of compressible plastic foam. Comes in many shapes. Often described as "disposable plugs." Elasticity lets them adapt easily to changes in ear canal.	Usually made of plastic or silicone rubber attached to a flexible stem for handling and insertion. Comes in many shapes and sizes to suit different ear canals.	Consists of two insulated plastic cups attached to metal or plastic band. Cups are equipped with soft cushions for seal and comfort. Headband tension ensures good seal.	Made from pliable material such as cotton/wax mixture, silicone putty, and mineral wool.	Custom made to fit a particular ear by taking an impression of the ear, making a mould, and casting a plug.	Commonly known as banded earplugs or canal caps. They consist of small caps or pods that are held in place over the ear canal by spring-loaded bands.
INTENDED USE	Most brands can be reused a few times before being discarded.	To be used more than once.	To be used regularly. Can be worn with or without plugs. Easily attached to hard hats.	• Single-use for mineral wool products. • Multi-use for cotton/wax products. • Semi-permanent for silicone putty products.	Permanent use	To be used more than once.
HYGIENE PRACTICES	Clean hands required each time fresh plugs are inserted.	Plugs should be cleaned regularly with warm soapy water, preferably after each removal from ear.	General maintenance required. Headband must be maintained. Cushions must be replaced when soiled or brittle.	Clean hands required for shaping and insertion.	Wash with hot water and soap, preferably after removal.	Wash with hot water and soap, preferably after removal.
ADVANTAGES	Low risk of irritation. One size fits most workers.	Reusable.	Less likely to cause irritation. Always available for use when attached to hard hat.	Relatively cheap	Good fit only if a proper impression of the ear is taken.	Good for when frequent removal is required.
DISADVANTAGES	Use requires clean hands. Large supply required for frequent removals and usage.	Plugs must be kept clean to prevent irritation. May produce some discomfort with pressure. Reusable, but may degrade over time. Inspect and replace as necessary.	Bands may wear out and tension decrease. Eyewear and hair may interfere with fit and reduce protection.	Not recommended for the noise levels found on construction projects.	If the wearer's weight changes drastically, new plugs should be made. Plugs can be lost, shrink, harden, or crack over time, and must be replaced.	Proper seal is necessary for good attenuation.

Effectiveness

The effectiveness of HPDs depend on the amount of time they are worn. What is not obvious to most wearers is that the effectiveness of HPDs can be reduced by as much as 95% or more if the protectors are not worn for as little as three or four minutes in noisy environments. It is therefore important to wear HPDs during the entire period of exposure in order to achieve the maximum protection available.

The effectiveness of HPDs also depends on the manner in which noise is transmitted through or around the protector. The following points should be noted.

- Even relatively small openings or air leaks in the seal between the hearing protector and the skin can typically reduce attenuation by 5 to 15 dB or more.
- Constant movement of the head or body vibration can lead to air leaks, so make regular adjustments when necessary to ensure a proper seal.
- Proper fitting is crucial to obtaining a reasonable degree of protection from an HPD.
- Hair, especially long hair and facial hair, can cause a poor fit.
- The effectiveness of earmuffs is greatly reduced if the tension of the headband decreases, whether due to normal use or alteration by the user.
- Modifying the earmuff by drilling holes in the earcups renders the protection useless.
- Anatomical differences such as ear canal size, jaw size, and head shape and size may affect the fit of earmuffs and earplugs. To accommodate these differences, HPDs should be made available to users in various shapes and sizes.
- Recreational headphones used to listen to music are **not** to be used as hearing protection.

Selection Criteria

In addition to attenuation characteristics, the following factors should be considered when selecting hearing protectors:

1. Noise exposure levels
2. Appearance
3. Comfort
4. Work environment or work procedures
5. Overprotection.

1. Noise Exposure Levels

Before choosing a hearing protector, it's important to find out the level of noise exposure that a worker will face throughout an entire working day.

As an example, a quick-cut saw may produce a noise level of 110 dBA. But the mason who operates it may only be exposed to an average of 92 dBA over the full eight-hour shift. The reason is that the saw is not operated continuously during that period. There will be times when the worker is laying brick, taking a coffee break, etc.

Ontario's Ministry of Labour (MOL) has developed *A Guide to the Noise Regulation,* which is available on their website:
labour.gov.on.ca/english/hs/pubs/noise/

The information below is taken from Appendix C: Selection of Hearing Protection Devices and De-Rating Schemes.

2. Appearance

HPD appearance may influence selection. Those that look bulky or uncomfortable may discourage potential users. Allowing workers to select from various HPDs, or various makes of the same HPD, can help overcome this problem.

According to CAN/CSA-Z1007: *Hearing Loss Prevention Program (HLPP) Management,* HPDs can be selected based on one of four methods:

1. Single Number Reporting Methods:
   a. Noise Reduction Rating or NRR Method
   b. Single Number Rating (subject fit 84th percentile) or SNR (SF84) Method
2. CSA Class Method
3. Octave-Band (OB) Computation Method
4. Field Attenuation Estimation System (FAES).

In Ontario, the NRR Method and CSA Class Method are the most common indicators used to estimate the level of protection afforded by a hearing protector. More details on these two methods are below. For full details on other methods for selecting HPDs, consult CSA-Z94.2-14: *Hearing Protection Devices – Performance, Selection, Care, and Use.*

Noise Reduction Rating (NRR) Method – a single number that describes the sound level reduction in decibels provided by the HPD. The NRR on the package often overestimates the reduction in noise provided by that HPD because the data is normally obtained in laboratory settings, which is not representative of real-world conditions.

Additionally the NRR is reported in C-weighted sound measurements, whereas measurements taken in the workplace typically use A-weighting. To account for these factors the NRR must be de-rated. CSA Z94.2-14 recommends the de-rating scheme in Table 14-2.

Table 14-2: Noise Reduction Rating (NRR) and De-Rating

Device Type	% of NRR Achieved	Predicted dBA Effective at the Ear
Earplugs	50%	L_{eq} - [NRR (0.5) - 3]
Earmuffs	70%	L_{eq} - [NRR (0.7) - 3]
Dual Protection	65%	L_{eq} - [NRR+5 (0.65) - 3]

NOTE: L_{eq} is the equivalent sound pressure level in dBA

Example: A restoration worker's exposure (L_{eq}) is 94 dBA. Earplugs used by the worker are assigned an NRR of 28. The predicted noise exposure (A-Weighted effective L_{eq}) is calculated as follows:

L_{eq} - [NRR (0.5) - 3] = XX dBA

94 dBA - [28 (0.5) - 3] = 94 - 11 = 83 dBA

CSA Class Method - HPDs may also be selected based on their CSA class. This method uses the letters A, B, or C to describe the range of reduction in sound level provided by an HPD.

Source: *A Guide to the Noise Regulation (O. Reg. 381/15) under the Occupational Health and Safety Act, Ontario Ministry of Labour, 2016.*

Table 14-3 provides guidelines for proper selection of HPDs based on class and noise exposure, presuming a desired effective exposure of L_{EX}, 8h = 85 dBA when HPDs are worn.

Table 14-3: Guidelines for Selecting HPDs

Level of Noise Exposure L_{EX} (dBA)	Class
< 90	C
91 to 95	B or BL*
96 to 105	A or AL*
> 105	Dual†

Source: *CSA Z94.2-14: Hearing Protection Devices - Performance, Selection, Care, and Use*

* AL or BL class HPDs meet the requirements for either Class A or Class B and have a minimum attenuation of 20 dB at 125 Hz.

† Dual hearing protection is required (Class B ear muff and Class A ear plug). Limit exposure duration. Octave-band analyses required for attenuation predictions and more frequent audiometric testing required.

Table 14-4 lists typical noise levels for various kinds of construction equipment. The upper limits of the noise levels can be used as a guide in selecting appropriate hearing protectors.

14-4: Typical Noise Levels of Tools and Equipment

Equipment	Noise Level (dBA)
Cranes	78 - 103
Backhoes	85 - 104
Loaders	77 - 106
Dozers	86 - 106
Scrapers	97 - 112
Trenchers	95 - 99
Pile drivers	119 - 125
Compactors	90 - 112
Grinders	106 - 110
Chainsaws	100 - 115
Concrete saw	97 - 103
Sand blasting nozzle	111 - 117
Jackhammers	100 - 115
Compressors	85 - 104

NOTE: These noise levels are measured at the operator's position.

3. Comfort

Comfort is an important consideration in selection. An HPD that isn't comfortable will simply not be worn or will be worn improperly.

With earplugs, several factors affect comfort. Since some plugs are relatively non-porous, they can often create a pressure buildup within the ear and cause discomfort. Dirty plugs may irritate the ear canal. Because of the shape of an individual's ear canals, certain plugs may not fit properly.

Earmuffs should be made of materials that do not absorb sweat and that are easy to maintain and clean. The earmuff cup should be adjustable to conform to various head sizes and shapes. Headband tension and earcup pressure should be adjusted so that they are effective without being uncomfortable. Weight may also be a factor.

Workers should be allowed to try out various HPDs to determine which are most comfortable.

4. Work Environment/Procedures

HPD selection is sometimes dictated by the constraints of the work area or work procedures. For example, large volume earmuffs may not be practical in confined work situations with little head room or clearance. In that case, flat-cup muffs or earplugs may be more practical.

Where work is necessary near electrical hazards, it may be desirable to use non-conductive suspension-type muffs. The choice of protector may also be affected by the nature of work, as in welding where certain types of earmuffs may interfere with the welder's helmet.

The attenuation of the muff-type hearing protector may be considerably reduced when worn with spectacle-type safety glasses. (The head configuration of the wearer and the type of glasses worn will determine the reduction in attenuation.)

Where safety glasses must be worn, cable-type temples should be used in order to allow the smallest possible opening between the seal of the protector and the head. Otherwise earplugs should be worn, provided they are adequate.

Consideration should be given to hearing protectors that can be attached to hard hats where exposures to noise may be high but intermittent and where hard hats must be worn at all times. Periodic adjustments may be necessary because movement of the hard hat may break the seal of the HPD.

Consideration should also be given to work involving oils, grease, and other products that may soil hands. Ear infections may occur when earplugs are inserted by dirty hands.

5. Overprotection

Workers wearing HPDs that provide too much attenuation may feel isolated from their surroundings. Sounds may be heard as muffled. Speech or warning sounds may be unrecognizable.

Overprotection can lead workers to resist wearing HPDs. Protectors should be chosen to provide sufficient, but not excessive, attenuation. The objective should be to reduce noise levels to or below the recommended maximum eight-hour exposure of 85 dBA, but not below 70 dBA.

Where communication is critical and hearing protection is required, communication headsets can be considered. These devices provide protection against harmful levels of noise, yet allow for important communication to be heard.

Fit, Care, and Use

According to the new Noise regulation (O. Reg. 381, s. 3), an employer who provides a worker with an HPD must provide adequate training and instruction to the worker in the care and use of the device, including its limitations, proper fitting, inspection and maintenance and, if applicable, cleaning and disinfection.

Training

Training should include a hands-on demonstration. Workers should then practice using the HPDs under close supervision. Checks are needed to ensure the best possible protection. Many of these checks relate to fit.

Workers should understand the following.

- There is risk of hearing loss if HPDs are not worn in noisy environments.
- To be effective, an HPD must not be removed even for short periods.
- Various HPDs are available to accommodate differences in ear canal size and shape, comfort level, compatibility with other forms of PPE, etc.
- Proper fit is essential to achieve maximum protection.

Earmuffs

1. Earmuffs should conform to the latest issue of CSA Standard Z94.2.
2. The cup part of the earmuff should fit snugly over the entire ear and be held firmly in place by a tension band.
3. The cup and band should not be so tight as to cause discomfort.
4. Cup, cushion, and band should be checked for possible defects such as cracks, holes, or leaking seals before each use of the HPD.
5. Because band tension can be reduced over a period of time, the band may require repair or replacement.
6. Defective or damaged parts should be repaired or replaced as needed. Tension band, cushions, and cups are readily replaceable. Consult the manufacturer's instructions for information related to the selection, care, and use of earmuffs.

Earplugs

1. Earplugs should conform to the latest issue of CSA Standard Z94.2.
2. Earplugs must be fitted snugly in the ear canal. This may cause some discomfort initially. However, in time (usually a period of two weeks) the discomfort vanishes. Should there be severe discomfort initially or mild discomfort for more than a few weeks, seek professional advice.

   In most instances it will only be a matter of re-sizing, although some ear canals cannot be fitted with plugs because of obstructions, unique shapes, or deformities. In fact, the shape of one ear canal may be entirely different from the other.
3. Reusable earplugs should be washed daily with warm soapy water to prevent the remote possibility of infection or other discomfort. When not in use, they should be kept in a clean container.
4. Earplugs with torn or otherwise damaged flanges should be replaced.

5. As best practice, use the method of insertion illustrated in Figure 14-4. Because the ear canal is slightly S-shaped, the ear must be pulled back to straighten the canal for the plug to fit properly.As best practice, use the method of insertion illustrated in Figure 14-4. Because the ear canal is slightly S-shaped, the ear must be pulled back to straighten the canal for the plug to fit properly.

1. Reach one hand around back of head.
2. Pull ear upwards to straighten S-shaped ear canal.
3. Insert plug with other hand according to manufacturer's instructions.

Figure 14-4: Inserting Earplugs

WARNING: Cotton batten does not provide adequate protection from construction noise.

Audiometric Testing

Workers who are exposed to noise levels that exceed 85 dBA, L_{ex}, 8hr should participate in audiometric testing. This testing is used to monitor an individual's hearing ability and determine the effectiveness of controls implemented in the workplace to minimize noise exposure for workers.

Two types of audiometric tests should be performed:

1. **Reference test –** a baseline test to which future audiometric tests are compared to.
2. **Monitoring test –** a periodic audiometric test compared to the reference test. This test is used to identify if hearing loss has occurred.

The results of audiometric tests can be used to do the following:

- Monitor patterns or trends in hearing loss if more than one worker has been impacted.
- Review work tasks to identify causal factors of hearing loss.
- Investigate engineering or administrative controls to reduce noise exposure.
- Verify proper use of hearing protective devices, ensure the correct type is used, that workers are able to fit them correctly, and that they are used consistently.
- Counsel and educate workers about noise in the workplace and as motivation to protect hearing.

Audiometric testing also provides an opportunity to examine HPDs used by workers. It is a good idea for workers to bring their hearing protectors to the test.

Summary

Control of noise in workplaces is of growing importance as a result of increasing hearing loss claims.

Most noise problems can be analyzed in terms of controlling the hazard:

1. At the source
2. Along the path
3. At the worker.

This is a convenient way of understanding the overall problem and a useful approach for putting control measures in place. The three components can usually be treated in isolation, although sometimes all three must be considered together in order to control unacceptable noise levels.

1. **At the source**, measures are aimed at reducing or eliminating the noise being generated.
2. **Along the path**, barriers can be introduced to reduce the amount of noise reaching the worker.
3. **At the worker**, measures involve personal protective equipment being properly selected, fitted, and worn. This PPE must be used in high noise environments **all the time.**

Failure to provide preventive or control measures will result in temporary and ultimately permanent hearing losses.

IHSA can assist workplaces by providing useful information, research, and training. For more information, including e-learning videos on the Basics of Hearing Protection, visit the personal protective equipment (PPE) topic page on our website.

16 HAND/SKIN PROTECTION

In construction, exposed hands and skin are susceptible to physical, chemical, and radiation hazards. Personal hand/skin protection is often the only practical means of preventing injury from

1. Physical hazards—heat, vibration, or sharp or jagged edges on materials and tools
2. Corrosive or toxic chemicals
3. Ultraviolet radiation.

Figure 16-1: Wear Gloves and Cover Exposed Skin To Protect Against Hazards

Physical Hazards

For physical hazards such as sharp edges, splinters, and heat, leather gloves are the preferred protection. Cotton or other materials do not stand up well and are recommended only for light-duty jobs.

Vibration transferred from tools and equipment can affect hands and arms. One result may be hand/arm vibration syndrome (HAVS). This disease causes the following changes in fingers and hands:

- Circulation problems such as whitening or bluish discoloration, especially after exposure to cold
- Sensory problems such as numbness and tingling
- Musculoskeletal problems such as difficulty with fine motor movements—for instance, picking up small objects.

Workers who use vibrating tools (e.g., jackhammers, grinders, riveters, compactors) on a daily basis may develop HAVS. Preventing this disease requires cooperation between employers and workers.

Employers

- Provide anti-vibration gloves and power tools with built-in vibration-reducing components.
- Ensure proper tool maintenance (worn grinding wheels or tool bearings can lead to higher vibration levels).
- Review exposure times and allow rest breaks away from vibrating tools.
- Train exposed workers in prevention techniques.

Workers

- Wear appropriate clothing in cooler weather to maintain core body temperature.
- Wear gloves whenever possible.
- Wear anti-vibration gloves when using power tools and equipment.
- Avoid smoking (it contributes to circulatory problems).
- Report any poorly functioning tools immediately.

Chemical Hazards

Review the safety data sheet (SDS) for any hazardous chemicals being used on site. It will identify whether gloves are needed and what kind. An SDS must be available on site for every hazardous product.

Table 16-1 identifies glove materials to be worn for protection against chemicals that may injure the skin. This information can be used if the SDS does not specify the type of gloves to be worn.

Table 16-1: Glove Selection Chart

Chemical Name	Glove Selection
Acetone	Butyl Rubber
Cellosolve	PVA, PVC, Neoprene
Cellosolve Acetate	PVA, PVC
Cyclohexane	NBR, Viton®
Hexane	Neoprene, NBR, PVA
Methyl Alcohol	Neoprene, Rubber, NBR
Methyl Chloroform	PVA, Viton®
Methyl Chloride	PVA, Viton®
Methyl Ethyl Ketone	Butyl Rubber
Methyl Isobutyl Ketone	Butyl Rubber, PVA
Mineral Spirits	Neoprene
Naphtha	NBR, PVA
Perchloroethylene	NBR, PVA, Viton®
Stoddard Solvent	NBR, PVA, Rubber
Toluene	PVA, Viton®
Turpentine	PVA, NBR
Trichloroethylene	PVA, Viton®
1, 1, 1 Trichloroethane	PVA, Viton®
1, 1, 2 Trichloroethane	PVA, Viton®
Xylene	PVA, Viton®
PVA = Polyvinyl Alcohol **NBR** = Nitrite Butyl Rubber	**PVC** = Polyvinyl Chloride **Viton®** = Dupont tradename product

CAUTION: Common glove materials have limited protective properties and do not protect against all hazards. Some solvents, degreasers, and other liquids can penetrate and/or dissolve rubber, neoprene, or PVC.

Ultraviolet Radiation

In recent years, there has been growing concern over the health risks of exposure to the sun's ultraviolet (UV) radiation. Construction workers are particularly at risk because they often work outdoors.

Long-term health risks of UV exposure include skin cancer. There has been an alarming increase in the incidence of skin cancer. Sunlight is the main source of UV radiation known to damage the skin and cause skin cancer. Exposure to the sun's UV radiation is widely recognized as a highly preventable cause of skin cancer.

Melanoma is the least common but most dangerous type of skin cancer. The incidence of melanoma in men is rising faster than all other cancers. According to the Canadian Dermatology Association (CDA), the mortality rate from malignant melanoma is increasing, particularly in middle-aged males.

Melanomas most often appear on the upper back, head, and neck. The CDA also notes that there is generally a lag time of 10 to 30 years for the clinical appearance of skin cancer to occur. Consequently, it is critical for young workers to beware of the cumulative effect of unprotected sun exposure. The more time they spend unprotected in the sun, the higher the risk of developing skin cancer.

Although most construction workers generally cover up their arms, legs, and torso on site, their faces and necks are still exposed to the sun's harmful rays. In addition, areas like the tips of the ears and the lips are often overlooked when it comes to sun protection.

The type of skin cancer that develops on the ear or the lip has a high chance of spreading to other parts of the body and causing death. Melanoma may also occur on the sun-exposed parts of the head and neck.

In fact the majority of skin cancers (two out of three) occur on the head and neck, followed by the forearm and back of the hand. Workers too often leave these critical areas exposed to the harmful effects of UV radiation.

Individual risk factors for developing skin cancer include the following.

- Fair skin that burns easily
- Blistering sunburns in childhood and adolescence
- Family history of melanoma
- Many freckles and moles.

In addition to the harmful effects of the sun's direct rays, some workers may be exposed to indirect UV radiation. Workers can receive additional radiation if they are on or near a surface that reflects sunlight. Reflective surfaces such as concrete, water, unpainted corrugated steel, building glass, and aluminum can increase the amount of ultraviolet radiation to which a worker is exposed.

Another source of indirect UV radiation is from the hard hat itself. UV rays can reflect off the hard hat onto a worker's face, magnifying the amount of UV exposure.

Although all construction workers are at risk, those who don't have ready access to shade and/or who work at heights are at a higher risk for UV overexposure. These trades include the following.

- Concrete finishing workers
- Roofers
- Rodworkers
- Formworkers on high-rise and residential sites
- Roadworkers
- Traffic signallers
- Ironworkers.

In addition, working at sites with southern exposure decreases the daytime shade available and increases UV exposure.

REMEMBER: Even on cloudy or hazy days, UV radiation can penetrate the atmosphere and burn your skin.

What Employers Can Do

- Supply workers with a broad-spectrum sunscreen with an SPF of 30 or higher.
- Ensure adequate shaded areas for workers on breaks and lunch.
- If possible, rotate workers to shaded areas of the jobsite.
- Educate workers on the hazards of UV radiation.
- Ensure that workers use UV-absorbent safety glasses.

What Workers Can Do

- Apply a broad-spectrum sunscreen with a sun protection factor (SPF) of 30 or greater to all exposed skin areas. Be sure to cover your ears and the back of your neck. Apply sunscreen 20 to 30 minutes before you go out in the sun. Reapply sunscreen every two hours.
- Use an SPF 30 or higher sunscreen lip balm and reapply every two hours. Skin cancers can develop on lips.
- Wear UV-absorbent safety glasses (CSA-approved polycarbonate glasses incorporate this feature).
- Wear clothing that covers as much of the skin as possible. Tightly woven material will offer greater protection as a physical block to UV rays.
- Try to find a shaded area for your breaks and lunch.

- If you sweat heavily, you may need to reapply sunscreen more often. Additionally, when clothing is wet, it loses some of its ability to block out the sun's rays. Ensure you have additional dry clothing if necessary.
- Add UV protection to the back of your neck by using a fabric neck protector that clips onto your hard hat (Figure 16-2).

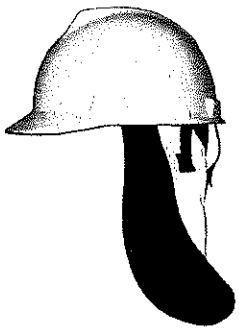


Figure 16-2: Neck Shield for Hard Hat

- Wear a wide-brimmed hard hat designed to protect your face and neck from the sun. Adding a glare guard under the peak of your hard hat will help reduce reflective UV rays (Figure 16-3).

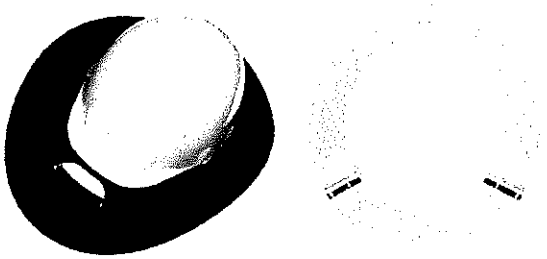


Figure 16-3: Sun Shields for Hard Hat

- Examine your skin regularly for any unusual changes. The most important warning sign for skin cancer is a spot on the skin that is changing in size, shape, or colour. The danger signs include any wound or skin patch that doesn't heal properly or scales. Be particularly attentive to any mole that grows or becomes irregular in shape, especially if it is multi-coloured. If anything looks unusual, see your doctor as soon as possible. Skin cancers detected early can almost always be cured.

NOTE: The majority of skin cancers are preventable. Taking basic precautions can significantly reduce the health effects of chronic sun exposure.