

Occupational Health and Safety Bulletin



Eye Protection at the Work Site

Introduction

In 2010, the Workers' Compensation Board reported that 2.5 per cent (601 in total) of all lost-time claims and 2.3 per cent (1080 in total) of all disabling injury claims in Alberta were related to eye injuries. According to the Centers for Disease Control and Prevention (CDC), each day approximately 2,000 U.S. workers experience a job-related eye injury. One third of these injuries are treated in hospital emergency rooms and more than 100 of these workplace eye injuries result in lost work time. It is widely accepted that most eye injuries can be prevented through the use of effective protective eyewear.

Legislation

Hazard Assessment

The Occupational Health and Safety (OHS) Code requires that employers assess a work site and identify existing and potential hazards before work begins at the work site or prior to the construction of a new work site. Section 8(1) of the OHS Code specifies that *“an employer must involve affected workers in the hazard assessment and in the control or elimination of the hazards identified”*.

Hazard Elimination and Control

Section 9 of the OHS Code specifies that, if reasonably practicable, an employer must eliminate or control a hazard through the use of engineering controls. If the hazard cannot be eliminated or controlled in this fashion, the employer must use administrative controls that control the hazard to a level as low as reasonably achievable. If the hazard cannot be eliminated or controlled by engineering or administrative controls, the employer must ensure that the appropriate personal protective equipment is used by workers affected by the hazard. When a hazard cannot be eliminated or controlled by one of these three control methods alone, the employer may use a combination of engineering controls, administrative controls or personal protective equipment if there is a greater level of safety because a combination is used.

Government of Alberta ■

Compliance with Standards

If eye protection equipment is used, section 229 of the OHS Code requires the employer ensure that the worker wears properly fitting eye protection equipment that is appropriate to the work being done and the hazard involved, and be approved to one of the following Canadian Standards Association (CSA) standards:

- (1) CSA Standard Z94.3-07, *Eye and Face Protectors*, or
- (2) CSA Standard Z94.3-02, *Eye and Face Protectors*, or
- (3) CSA Standard Z94.3-99, *Industrial Eye and Face Protectors*.

These standards may be viewed here <http://ohsviewaccess.csa.ca/>

Prescription safety eyewear which has glass lenses *does not* meet the impact requirements of the CSA Z94.3 Standards. If there is a danger of impact, prescription eyewear having glass lenses must not be used unless it is worn behind equipment that meets the requirements of one of the three CSA Standards. If there is *no* danger of impact *and* the use of plastic prescription lenses is impracticable, a worker may use prescription lenses made of treated safety glass that meets the requirements of one of these American National Standards Institute (ANSI) standards:

- (1) ANSI Standard Z87.1-2003, *Occupational and Educational Personal Eye and Face Protection Devices*, or
- (2) ANSI Standard Z87.1-1989, *Practice for Occupational and Educational Eye and Face Protection*.

If prescription safety eyewear has lenses that meet the requirements of CSA Standard Z94.3-07, it is permissible that the frames meet the requirements of ANSI Standard Z87.1-2003 in place of the requirements of one of the three CSA Z94.3 Standards.

For workers that must wear a full face piece respirator where there is a danger of impact to the eye, the employer must ensure that the face piece:

- a) meets the requirements of
 - i) CSA Standard Z94.3-07, *Eye and Face Protectors*, or
 - ii) CSA Standard Z94.3-02, *Eye and Face Protectors*, or
- b) meets the impact and penetration test requirements of section 9 of
 - i) ANSI Standard Z87.1-2003, *Occupational and Educational Personal Eye and Face Protection Devices*, or
 - ii) ANSI Standard Z87.1-1989, *Practice for Occupational and Educational Eye and Face Protection*.

Contact Lenses

Section 230 of the OHS Code states that “*an employer must ensure that, if wearing contact lenses poses a hazard to the worker’s eyes during work, the worker is advised of the hazards and the alternatives to wearing contact lenses*”.

Emergency Baths, Showers and Eye Wash Equipment

Section 24 of the OHS Code states “*if a worker is present a work site where chemicals harmful to the eyes or skin are used, the employer must ensure that the worker has immediate access at the work site to emergency baths, showers, eye wash equipment or other equipment appropriate for the potential level of exposure*”.

Industrial Lasers

The Radiation Protection Regulation states:

17(2) The owner shall ensure that the installation of, and the employer shall ensure that the use of, lasers and laser systems

- (a) in a health care facility comply with CAN/CSA-Z386-01, “*Laser Safety in Health Care Facilities*” published by the Canadian Standards Association, and
- (b) other than in a health care facility comply with ANSI Standard Z136.1-2000, “*American National Standard for the Safe Use of Lasers*” published by the American National Standards Institute.

Both the CSA-Z386-01 and the ANSI Z136.1-2000 Standard require, in section 4.6.2 of each standard, that protective eyewear for use with Class 3B and Class 4 lasers be “*permanently labeled with the optical density and wavelength for which protection is afforded*” and that “*periodic cleaning and inspection shall be made of protective eyewear to ensure the maintenance of satisfactory condition*”.

Comparison of Standards for Protective Eyewear

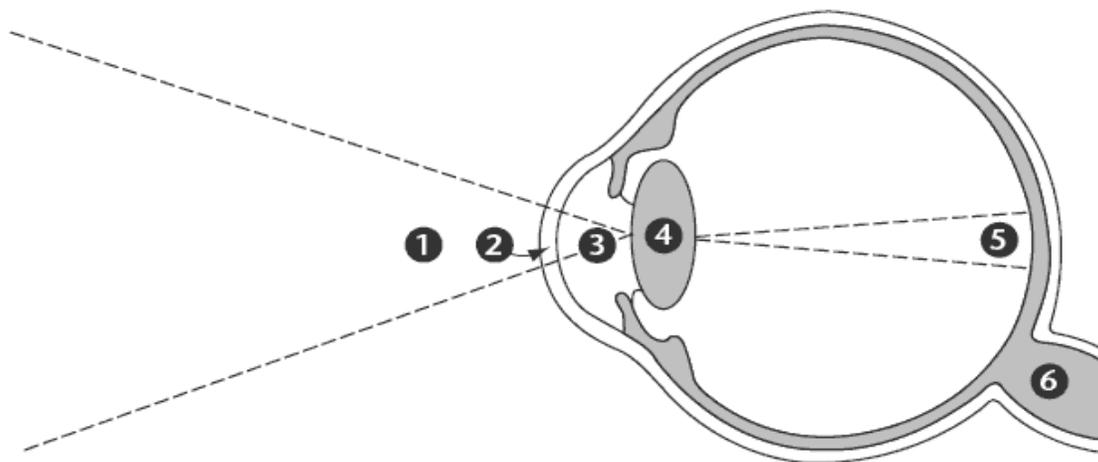
Both CSA and ANSI publish standards for eye and face protectors. The Canadian standard is CAN/CSA Z94.3, and the American standard is ANSI Z87.1. Both standards outline test methods and minimum performance requirements for impact resistance, flammability/ignition, refractive power, resolving power, prismatic deviation, haze and luminous transmittance. **However, there are some major differences between these standards which include:**

- ANSI Standard includes “*Non-Impact*” eye and face protectors that *do not* protect the wearer from hazards of a high velocity nature or high mass nature. High velocity impact tests involve propelling a 0.25 inch diameter steel ball at the complete protective device at a velocity between 45.72 m/s and 91.44 m/s, depending on the device. High mass impact tests involve dropping a pointed projectile weighing 500 g from a height of 127 cm on to the complete protective device. The lenses and frames of protectors that pass the high mass impact and high velocity impact tests are deemed “*Impact*” rated and are marked with a “+” symbol to indicate the impact protection provided.
- ANSI Standard has a higher velocity requirement for High Velocity Impact tests conducted on goggle lenses and frames, full face piece respirators, face shields, welding helmets and welding hand shields.

- ANSI Standard has a High Mass Impact performance requirement for spectacle lenses (non-prescription) and frames, goggle lenses and frames, welding helmets and hand shields, full face piece respirators and face shields.
- ANSI Standard has a Penetration Test performance requirement for spectacle lenses (non-prescription), goggle lenses, welding helmet and hand shield lenses, full face piece respirators and face shields. The complete protective device passes this test if a weighted needle with a total weight of 44.2 g dropped from a height of 127 cm fails to penetrate the lens.
- ANSI Standard specifies minimum thickness requirements for spectacle lenses, goggle lenses (basic impact type only), face shields and welding helmet and hand shield lenses, whereas the CSA Standard only specifies minimum thickness requirements for non-glass prescription lenses.
- CSA Standard specifies minimum frontal and side coverage dimensions for spectacle lens and side protectors, and minimum dimensions for face shield windows and welding helmet and hand shield filter/cover plates, whereas the ANSI Standard only specifies minimum frontal and side coverage dimensions for spectacle lens and side protectors.
- CSA Standard requires side protection on all spectacles, whereas the ANSI Standard only requires side protection on spectacles which are *Impact Rated*.
- CSA Standard specifies a minimum field of view requirement for goggles and Class 7A and 7C respirators.
- Protective eyewear must be certified by CSA (or other accredited agency) as meeting the requirements outlined in the standard in order to bear the CSA mark (or accrediting agency's mark).

Anatomy of the Eye

Source: CSA Z94.3.1-09 *Selection, use, and care of protective eyewear*



1. Light strikes an object in your field of vision and is REFLECTED to your eyes.
2. Light passes through the CORNEA (transparent "front window" of the eye).
3. The PUPIL (the opening at the centre of the coloured IRIS) changes size to allow the correct amount of light through.

4. The CRYSTALLINE LENS focuses light rays onto the retina.
5. The RETINA (rear inner lining of the eye that contains light-sensitive cells) converts light into electrical signals.
6. The OPTIC NERVE carries these signals to the brain, which combines the images from each eye into a single picture.

Hazards and Protective Equipment Selection

It is not always possible to eliminate hazards. If risk of injury to a worker's eyes is present at a workplace, and engineering and administrative controls are not possible (or sufficient on their own), then the employer must ensure that the affected worker's eyes are protected by a suitable form of personal protective equipment.

Hazards that may warrant the use of protective eyewear include:

- Impact from particles, dust, wind or molten metals
- Splash from chemicals
- Exposure to heat
- Exposure to glare
- Exposure to optical radiation
- Exposure to infectious agents

The cornea has more pain receptors per square centimeter than any other body part, and scars easily. It is crucial that the protective eyewear selected protect workers from all of the potential hazards they may be exposed to. Some protective eyewear protects the worker from only one type of hazard, while other types provide protection for multiple hazards. If one type does not provide the required protection, it may be necessary for the worker to wear multiple types of equipment at the same time (e.g. Class 1A spectacles for impact protection behind a Class 3 welding helmet for radiation protection from welding arc).

Biological Hazards

Although the CSA and ANSI Standards do not address protective eyewear for exposure to infectious agents, the CDC has information available on their website <http://www.cdc.gov/niosh/topics/eye/eye-infectious.html>. According to the CDC, some infectious diseases can be transmitted through the mucous membranes of the eye. These include herpes viruses, rhinoviruses and viruses and bacteria that can cause conjunctivitis. Indirectly-vented and non-vented goggles provide reliable, practical eye protection from splashes, sprays, and respiratory droplets. To provide better face and eye protection from splashes and sprays, a face shield equipped with crown and chin protection should be used in addition to these goggles. Full face piece elastomeric respirators and powered air-purifying respirators may be required for even greater protection against infectious agents.

Contact Lenses

Studies have shown that exposure of the eye to electric or welding arcs cannot “weld” contact lenses to the cornea. Also, it has never been verified that they can freeze to the eye in very cold environments. However, in dusty environments particles may become trapped behind the lenses and cause scratching of the cornea. Additionally, chemicals splashed into the eyes of contact lens wearers may be more difficult to wash out, and soft contact lenses may absorb some chemicals resulting in a continued source of eye irritation.

CSA Classification of Protective Eyewear:



Class 1A
Spectacles with side protection



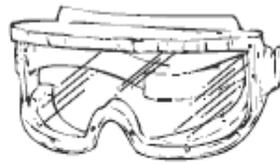
Class 1B
Spectacles with side and radiation protection



Class 2A
Direct ventilated goggles



Class 2B
Non-ventilated goggles



Class 2C
Direct/non-ventilated with radiation protection



Class 3
Welding helmets



Class 4
Welding hand shields



- Class 5A Non-rigid helmet (hood) with impact-resistant window
- Class 5B Non-rigid helmet (hood) for dust, splash, and abrasive materials protection
- Class 5C Non-rigid helmet (hood) with radiation protection
- Class 5D Non-rigid helmet (hood) for high-heat applications



- Class 6A Face shield for impact and splash protection
- Class 6B Face shield for radiation protection
- Class 6C Face shield for high-heat application



Class 7A



Class 7B



Class 7C



Class 7D

- Class 7A Respirator facepiece for impact and splash protection
- Class 7B Respirator facepiece for radiation protection
- Class 7C Respirator facepiece with loose-fitting hoods or helmets
- Class 7D Respirator facepiece with loose-fitting hoods/helmets for radiation protection

Although it is not indicated in the diagrams above, Classes 2B and 2C include goggles that have indirect ventilation (i.e. ventilation holes that do not allow passage of a 1.5 mm diameter rod).

There are many types of tints and filters available for control of exposure to glare, ultraviolet (UV) radiation and infrared (IR) radiation. Tinted, photochromic and polarized lenses reduce light transmission but do not contain any other absorbing properties. Filters (available in shades 1.5 to 14) are designed to filter out harmful UV and IR radiation created during welding, cutting and soldering. Automatic-darkening welding filters are also available.

Protective Eyewear Selection Guide:

Nature of hazard	Typical hazardous activities	Spectacles		Goggles			Welding helmet Class 3	Welding hand shields Class 4	Non-rigid hoods				Face shields Class 6		
		Class 1		Class 2					Class 5				Class 6		
		A	B	A	B	C			A	B	C	D	A	B	C
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, lathe work, etc.	✓		✓	✓				✓	✓			✓		
Flying particles, dust, wind, etc.	Woodworking, sanding; light metalworking and machining; exposure to dust and wind; resistance welding (no radiation exposure); sand cement, aggregate handling; painting; concrete work, plastering; material batching and mixing	✓		✓	✓				✓	✓			✓		
Heat, sparks, and splash from molten materials	Babbiting, casting, pouring molten metal; brazing, soldering, spot welding, stud welding; hot dipping operations		✓			✓					✓	✓		✓	✓
Acid splash; chemical burns	Acid and alkali handling; degreasing, pickling and plating operations; glass breakage; chemical spray; liquid bitumen handling				✓					✓				✓	
Abrasive blasting materials	Sand blasting; shot blasting; shotcreting				✓				✓					✓	
Glare, stray light	Reflection, bright sun, and lights; reflected welding flash; photographic copying	✓		✓	✓				✓	✓				✓	
Injurious optical radiation (where moderate reduction of optical radiation is required)	Torch cutting, welding, brazing, furnace work; metal pouring, spot welding, photographic copying		✓			✓						✓			✓
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: Based on Table A.1 of CSA Standard Z94.3-07 *Eye and Face Protectors*

Lasers - Classes, Hazards and Eye Protection

Laser classifications are based mainly according to their wavelength and power output:

Class 1 and 1M lasers are low powered and include barcode scanners, laser printers and CD players. Laser safety eyewear is not required. Safe viewing occurs at all exposure levels for Class 1. A Class 1M laser is safe for all conditions of use except when the beam is viewed directly through magnifying optics such as binoculars, telescopes and microscopes.

Class 2 and 2M lasers are low powered and include laser pointers and barcode scanners. The blink reflex of the eye will limit exposure to less than 0.25 seconds. Do not stare at the beam, nor view Class 2M beams through magnifying optics.

Class 3R lasers are intermediate powered and include laser sights for firearms, laser levels and laser pointers. While momentary exposure to the direct or reflected beam is unlikely to cause injury, staring at the beam and viewing of the beam through magnifying optics should be avoided.

Class 3B lasers are moderately powered and include lasers used for physiotherapy treatments and many research lasers. Protective eyewear is typically required where direct viewing of a class 3B laser beam may occur.

Class 4 lasers are high powered and include lasers used for surgery, drilling, cutting, welding, and micromachining. Appropriate protective eyewear must be worn. Most laser eye injuries occur from reflected beams of class 4 laser light, so keep all reflective materials away from the beam.

Retinal injuries can occur instantaneously with Class 3B and Class 4 lasers and the damage may be irreparable. Corneal burns from far-IR and UV lasers may also be irreparable. Class 4 beams may be of sufficient power intensities to penetrate through the sclera (white) of the eye and damage the retina and other structures. Thus, turning one's head or not looking directly at the laser offers little or no protection to high power lasers. Lenticular damage may also be caused by the beam and by photochemical reactions from exposure to UV and blue frequencies.

Potential symptoms of a laser eye injury include:

- Popping sound caused by a laser-induced explosion of the retina
- Flash of light
- Immediate pain
- Subsequent headaches
- Excessive watering of the eye
- Sudden appearance of “floaters”
- Black spot present in the field of vision

As mentioned earlier in this document, protective eyewear for use with Class 3B and Class 4 lasers must be permanently labeled with the optical density and wavelength for which protection is afforded, and periodically cleaned and inspected to ensure the maintenance of satisfactory condition. The CSA Standard Z94.3 does not address laser protection. Further information on lasers can be obtained from ANSI Standard Z136.1-2007, *American National Standard for the Safe Use of Lasers* and CSA Standard Z386-08, *Safe Use of Lasers in Health Care Facilities* (2008).

The CSA Standard Z386-08 may be viewed here <http://ohsviewaccess.csa.ca/>

For more information



http://employment.alberta.ca/documents/WHS/WHS-PUB_mg001.pdf

Guideline for the Use of Contact Lenses in Industry



http://employment.alberta.ca/documents/WHS/WHS-LEG_ohsc_p18.pdf

Occupational Health and Safety Code Explanation Guide – Part 18, PPE



http://www.qp.alberta.ca/574.cfm?page=2003_182.cfm&leg_type=Regs&isbncln=0779731042

Radiation Protection Regulation

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Province-Wide Contact Centre



Edmonton
780-415-8690



Other locations
1-866-415-8690
(Toll Free)



Deaf or hearing impaired

- Edmonton 780-427-9999
- Other locations 1-800-232-7215
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