

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

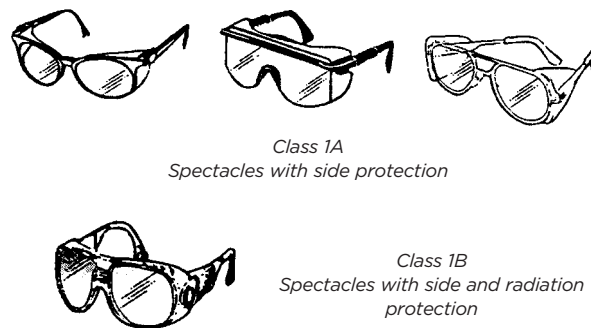
Class 6 - Face Shields

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).

Figure 11-1: Types of Class 1 Eye Protection



Goggles (Class 2 Eye Protection)

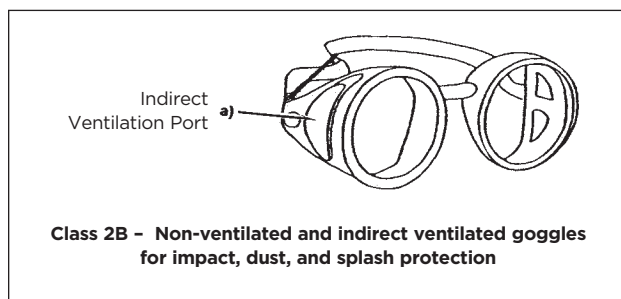
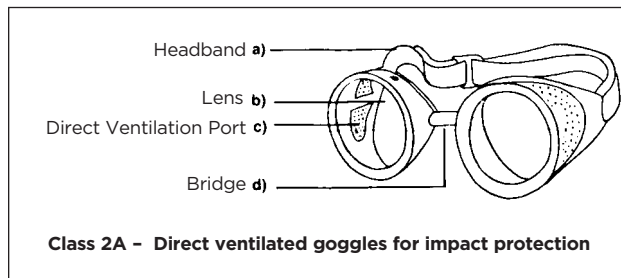
There are two types of goggles:

1. Eyecup goggles
2. Cover goggles.

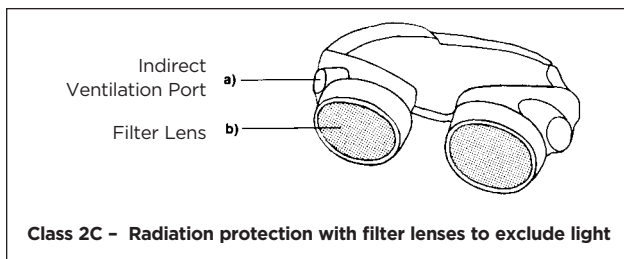
Both must meet the CAN/CSA Z94.3-15.

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.

Figure 11-2: Eyecup Goggles

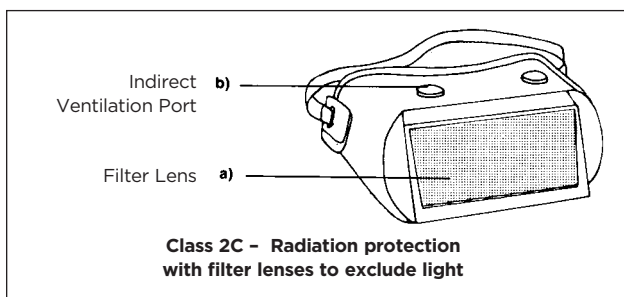
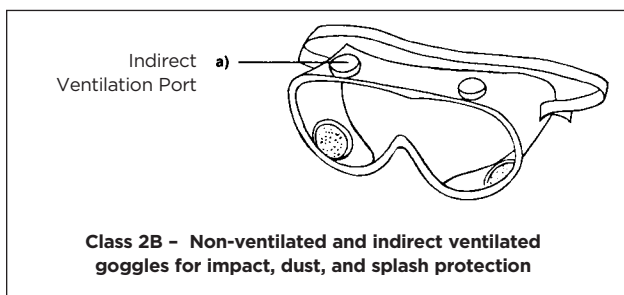
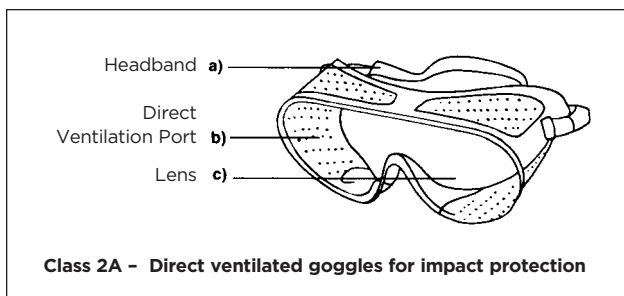


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Cover goggles (Figure 11-3) are designed to be worn over spectacles. Like eyecup goggles, they have adjustable or elasticized headbands and are equipped with direct or indirect ventilation ports to allow air in and prevent fogging. While both models keep out large particles, indirect-vented goggles are better at keeping out liquids and dusts.

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:

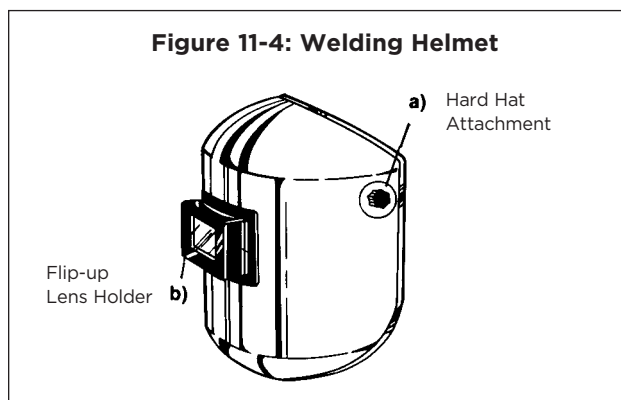
1. Stationary plate helmet
2. Lift-front or flipup plate helmet (Figure 11-4).

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.



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.

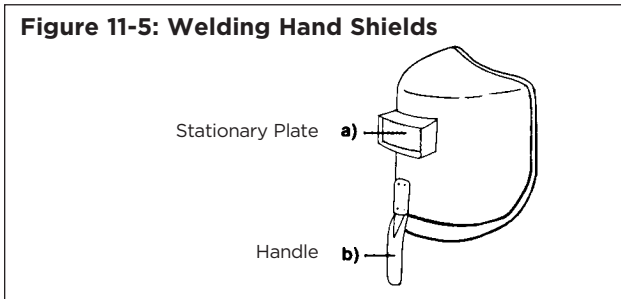
In addition to common green filters, many special filters are also available. Some improve visibility by reducing yellow or red flare; others make the colour judgment of temperature easier. A special gold coating on the filter lens provides additional protection by reflecting radiation.

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



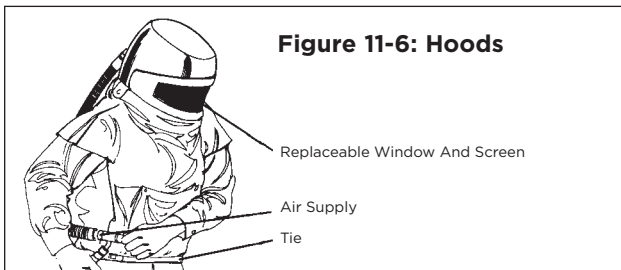
Hoods (Class 5 Eye Protection)

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, Class 1 spectacles should be worn underneath.

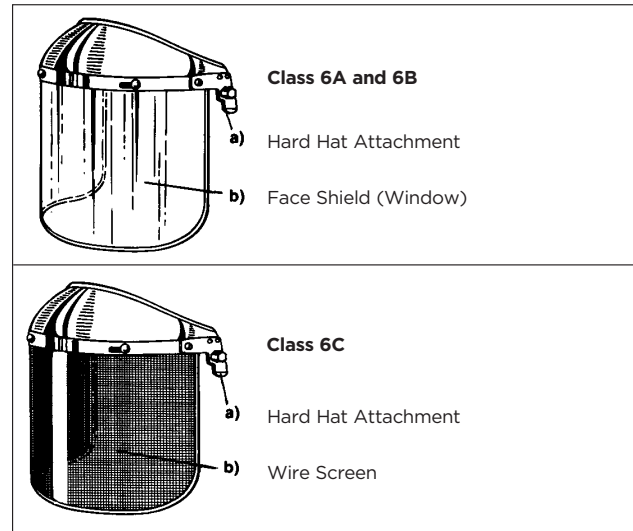
Face shields may be equipped with an adjustable spark deflector or brow guard that fits on the worker's hard hat. Shaded windows are also available to provide various degrees of glare reduction; however, they do not meet the requirements of CSA Standard Z94.3-15 *Eye and Face Protectors* for ultraviolet and total heat keep together and should not be used in situations

where any hazard is present from ultraviolet 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

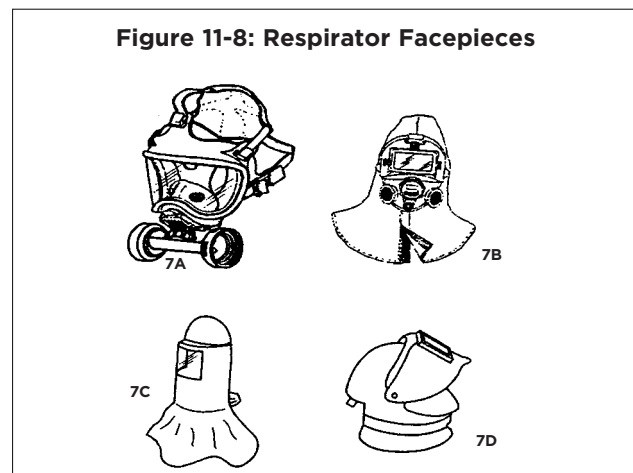


Table 11-1: Recommended Shade Numbers for Arc Welding and Cutting

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
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										

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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.

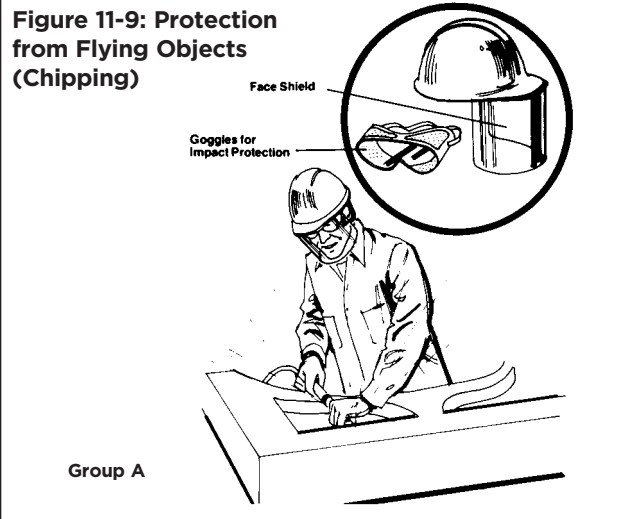
It is strongly recommended that employers require all construction personnel to wear Class 1 eye protection (spectacles). Spectacles should also be worn underneath Classes 3, 4, 5, 6, or 7 eye protectors if they're needed to prevent a hazard.

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.



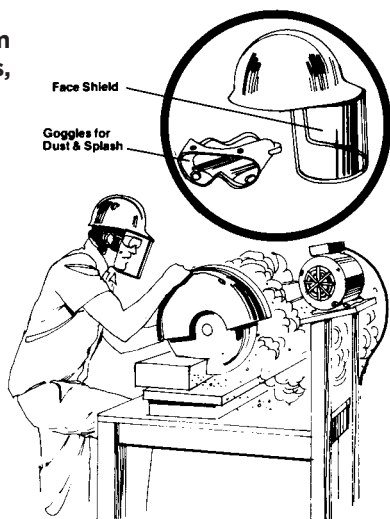
Group B: Flying Particles, Dust, Wind, etc.

(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)**

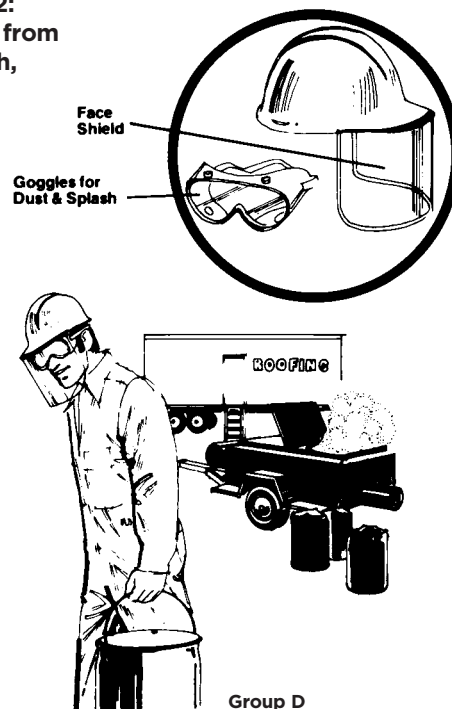
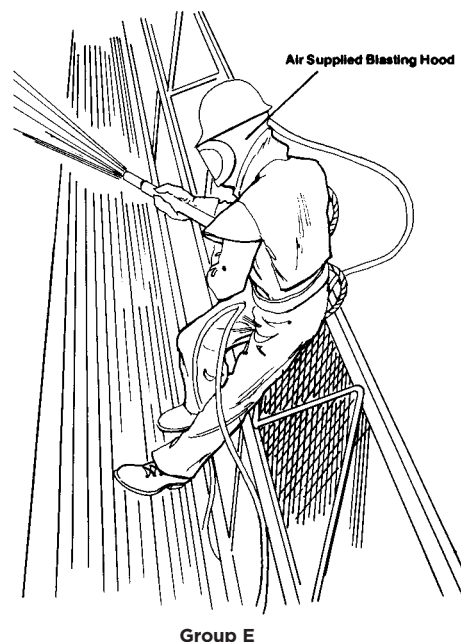


Figure 11-13: Protection from Abrasive Blasting



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.

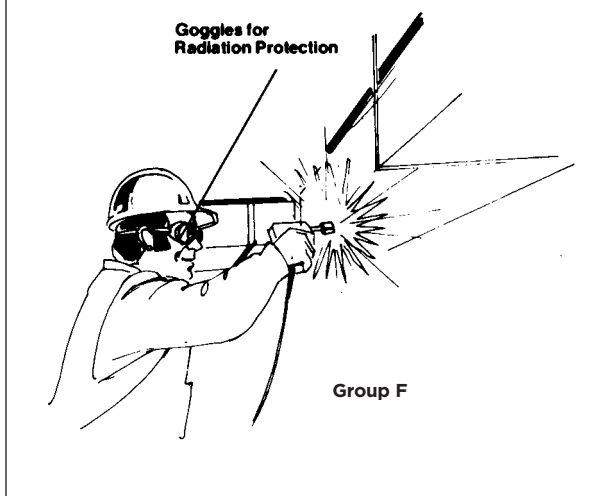
Group F: Glare, Stray Light

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

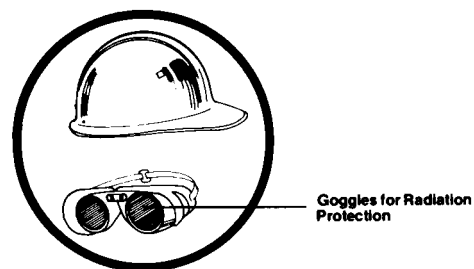


Group G: Injurious Radiation

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.

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



Group G



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).

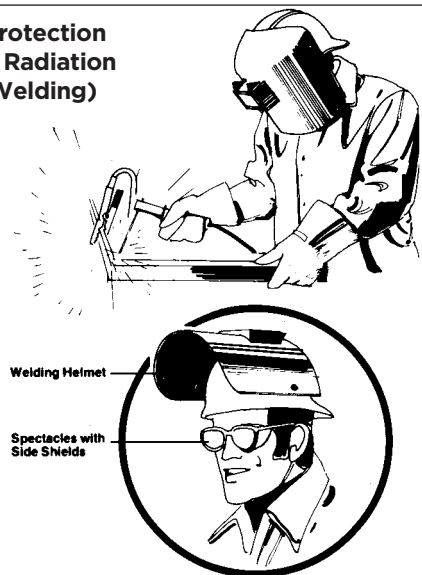
Group H: Injurious Radiation

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)

Group H



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.

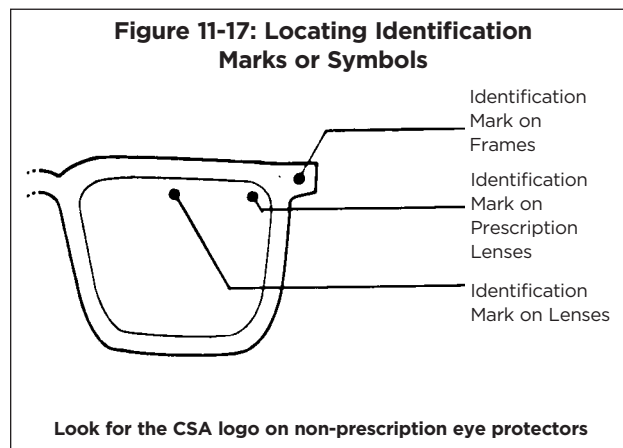
The polycarbonate materials used in safety glasses provide the best protection, while regular plastic

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.



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																

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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.