

11 EYE PROTECTION

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Introduction

Eye protection is not the total answer to preventing eye injuries. Education regarding proper tools, work procedures, hazard awareness, and the limitations of eye protection is also very important. Like any other manufactured product, eye protection has material, engineering, and design limitations. But proper eye protection, selected to match the specific construction hazard, combined with safe work procedures, can help to minimize the number and severity of eye injuries.

When we consider 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 over-emphasized. In the hazardous environment of the construction industry, wearing proper eye protection should be considered a labour-management policy, not a matter of individual preference.

Classes of Eye Protectors

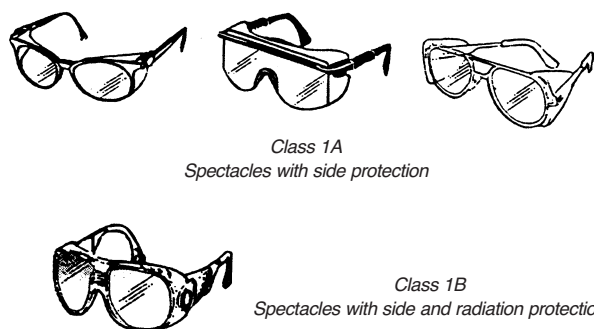
Before outlining the type(s) of eye protectors recommended for a particular work hazard, it is necessary to explain the various types of eye protectors available. Eye protectors are designed to provide protection against three types of hazards — impact, splash, and radiation (visible and invisible light rays) — and, for purposes of this manual, are grouped into seven classifications based on the CSA Standard Z94.3-07, *Industrial Eye and Face Protectors*.

The seven basic classes of eye protectors are: spectacles, goggles, welding helmets, welding hand shields, hoods, face shields, and respirator facepieces.

Class 1 – Spectacles (Figure 3)

CSA Standard Z94.3-07 requires that Class 1 spectacles incorporate side protection. Most side shields are permanently attached to the eyewear, but some may be detachable.

Figure 3 – Examples of Class 1 Spectacles

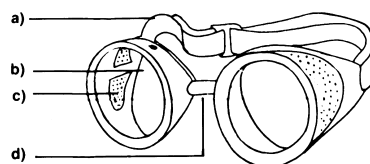


Class 2 – Goggles

There are two types of goggles — eyecup and cover. Both must meet the CSA Z94.3-07 Standard.

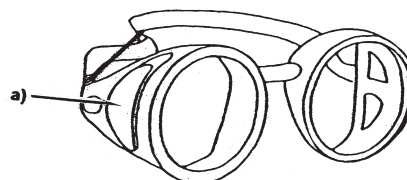
Eyecup goggles (Figure 4) completely cover the eye socket to give all-round protection. They have adjustable or elasticized headbands and are equipped with ventilation ports to allow passage of air and prevent fogging. Some have direct ventilation ports which prevent the direct passage of large particles, but do not exclude dust or liquids. Others have indirect ventilation ports which prevent the passage of particles, dust, and liquids. There are also models available with an adjustable chain bridge.

Figure 4 – Eyecup Goggles



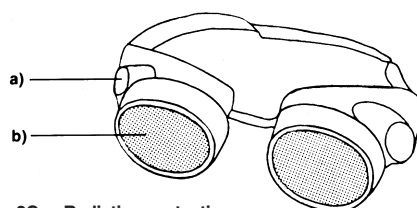
Class 2A – Direct ventilated goggles for impact protection

Eyecup goggles with direct ventilation openings or ports. These openings exclude direct passage of large particles. They do not exclude dust and splash. a) headband; b) lens; c) direct ventilation port; d) bridge.



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

Eyecup goggles with indirect ventilation ports to exclude direct passage of dust or liquids. These goggles are identical to class 2A except for the type of ventilation ports. a) indirect ventilation port.

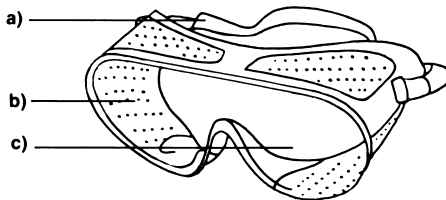


Class 2C – Radiation protection

Eyecup goggles for radiation protection with indirect ventilation ports not only to allow passage of air and prevent fogging, but also to exclude light. The lenses in these goggles are filter lenses. a) indirect ventilation port; b) filter lens.

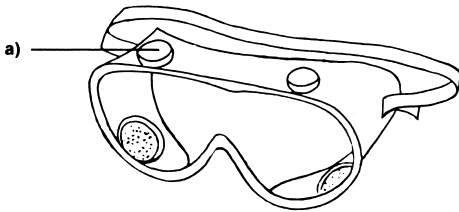
Cover goggles (Figure 5) are designed to be worn over spectacles. They have adjustable or elasticized headbands and are equipped with direct or indirect ventilation ports to allow passage of air and prevent fogging.

Figure 5 – Cover Goggles



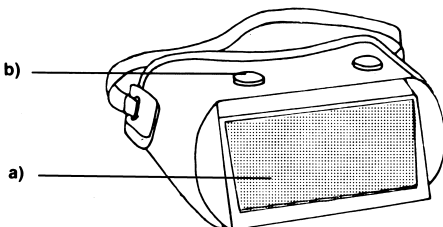
Class 2A – Direct ventilated goggles for impact protection

Cover goggles with direct ventilation ports. (This type normally incorporates a soft-frame goggle.) As in class 2A eyecup goggles, these openings or ports exclude direct passage of large particles. They do not exclude dust and splash. a) headband; b) direct ventilation port; c) lens.



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

Cover goggles for dust and splash with indirect ventilation ports to exclude direct passage of dust or liquid. a) indirect ventilation port.



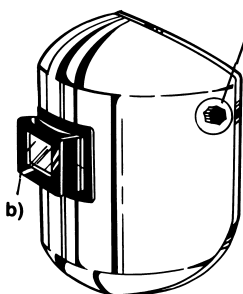
Class 2C – Radiation Protection

Cover goggles for radiation protection. a) filter lens; b) indirect ventilation port.

Class 3 – Welding Helmets (Figure 6)

This class provides radiation and impact protection for face and eyes. There are two types of welding helmets available — the stationary plate helmet and the lift-front or flip-up plate helmet. 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 lenses.

Figure 6 – Welding Helmets



Lift-front helmets or shields have three plates or lenses — a filter or shaded plate made of glass or plastic in the flip-up cover, along with a clear thin glass or plastic outer lens to keep it clean, and a clear, impact-resistant plastic or glass lens mounted in the helmet itself. a) hard hat attachment; b) flip-up lens holder.

Stationary plate helmets are similar to lift-front helmets except for the fact that they have a single filter lens plate, normally 51mm x 108mm (2" x 4-1/4") in size, or a larger plate 114mm x 113mm (4-1/2" x 5-1/4") in size which is more suitable for spectacle wearers.

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 of the closeness of the eyes to the arc and lack of atmospheric protection. 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 1.

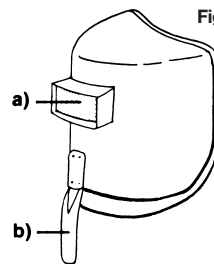
In addition to common green filters, many special filters are also available. Some improve visibility by reducing yellow or red flare; others make the colour judgment of temperature easier. A special gold coating on the filter lens provides additional protection by reflecting radiation.

Class 4 – Welding Hand Shields (Figure 7)

Welding hand shields are designed to give radiation and impact protection for the face and eyes.

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 7 – Hand Shields



Hand-held shields or inspectors' shields are similar to Class 3 welding helmets except that there are no lift-front type models. a) stationary plate; b) handle.

Class 5 – Hoods (Figure 8)

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.

Hood types include

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

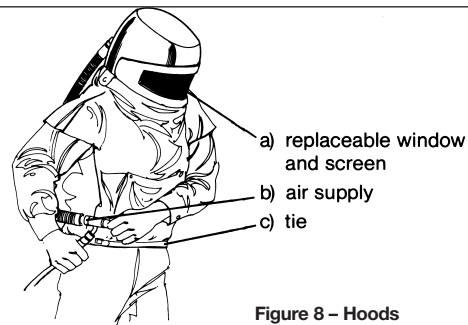


Figure 8 – Hoods

Class 6 – Face Shields (Figure 9)

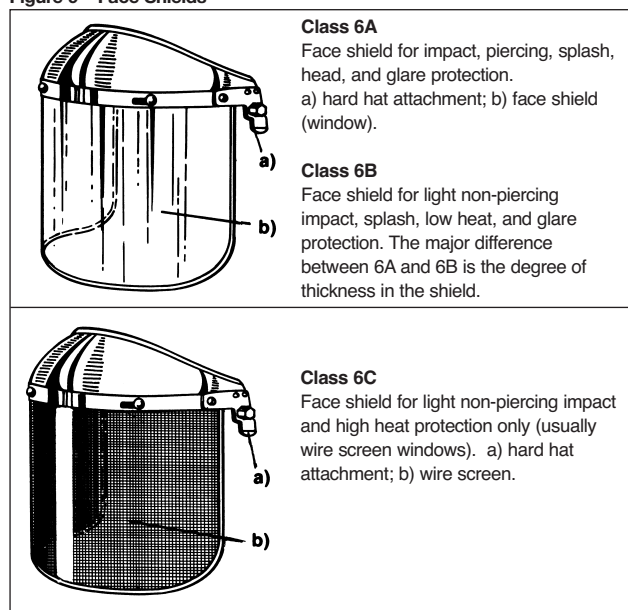
Face shields are just what the name implies—a device that includes a transparent window or visor to shield the face and eyes from impact, splash, heat, or glare. With face shields, as with welding helmets and hand shields, the user is continually lifting and lowering the visor. To protect the eyes when the visor is lifted, Class 1 spectacles should be worn underneath. Face shields may also 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 Z94.3-07 *Industrial Eye and Face Protectors* for ultraviolet and total heat protection and should not be used in situations where any hazard is present from ultraviolet or infrared radiation.

Class 6

This class includes

- 6A for impact and splash protection
- 6B for radiation protection
- 6C for high-heat applications.

Figure 9 – Face Shields

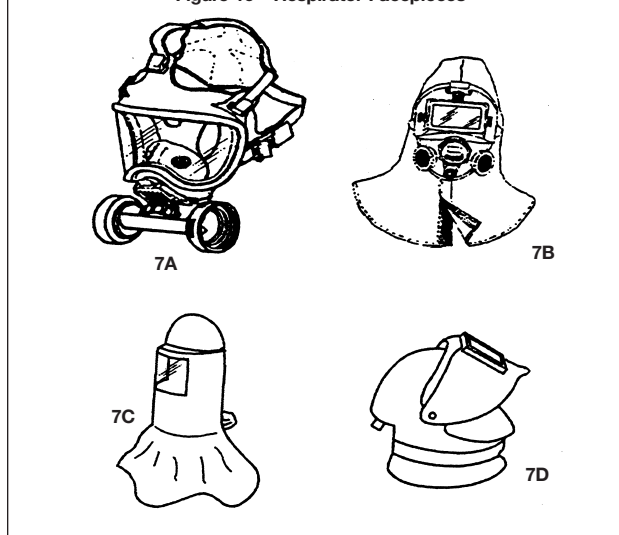


Class 7 – Respirator Facepieces (Figure 10)

This class includes

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

Figure 10 – Respirator Facepieces



Hazards and Recommended Protectors

Reprinted from CSA Standard Z94.3-07 *Industrial Eye and Face Protectors*, Table 2 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.

The practice of requiring all personnel to wear spectacles is strongly recommended. Spectacles should be worn underneath Classes 3, 4, 5, 6, or 7 protectors, where the hazard necessitates the use of spectacles.

The following classifications provide a general overview of eye protectors for each hazard group. For specific hazards, refer to Table 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)

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 12)

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.

Group C: Heat, Glare, Sparks, and Splash from Molten Metal (Figure 13)

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.

Table 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	
	1.0	5.0	15	30	60	100	150	200	250	300	400	500														

Figure 11

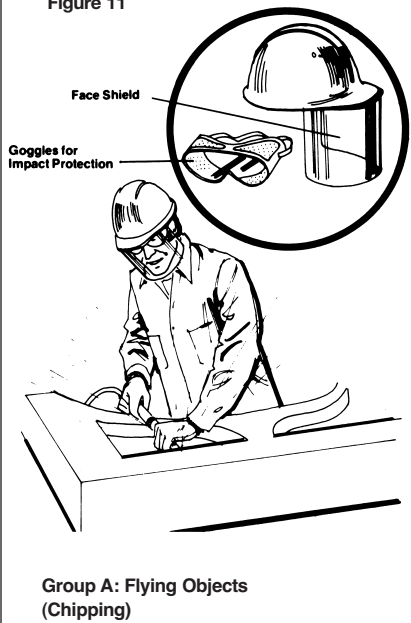


Figure 12

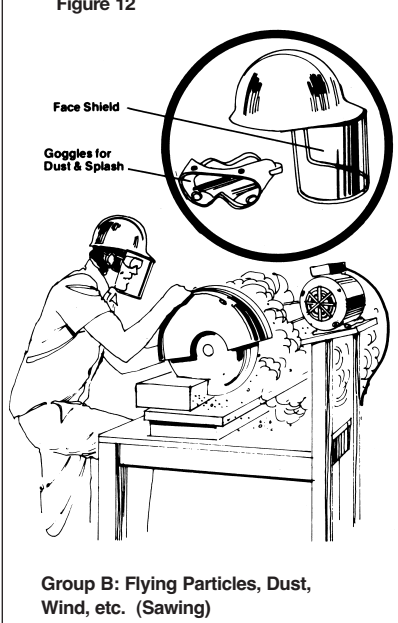
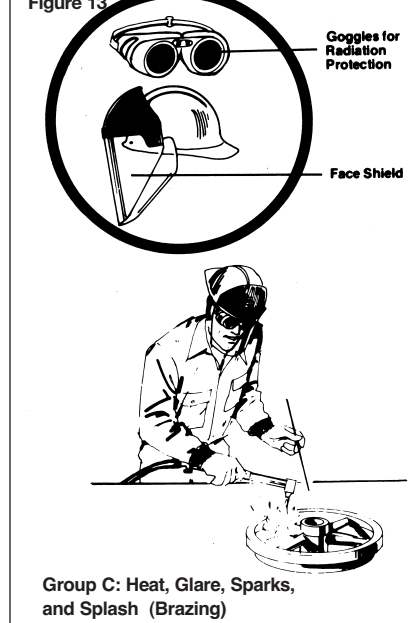


Figure 13

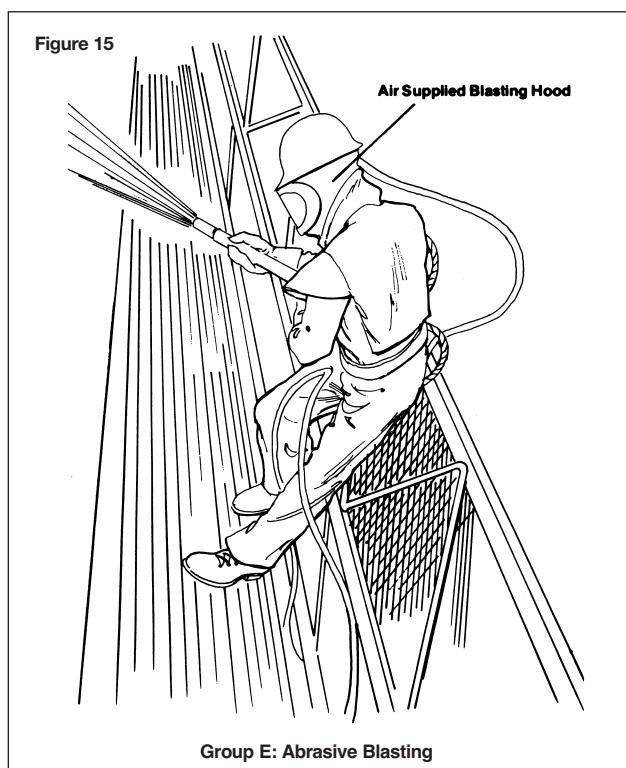
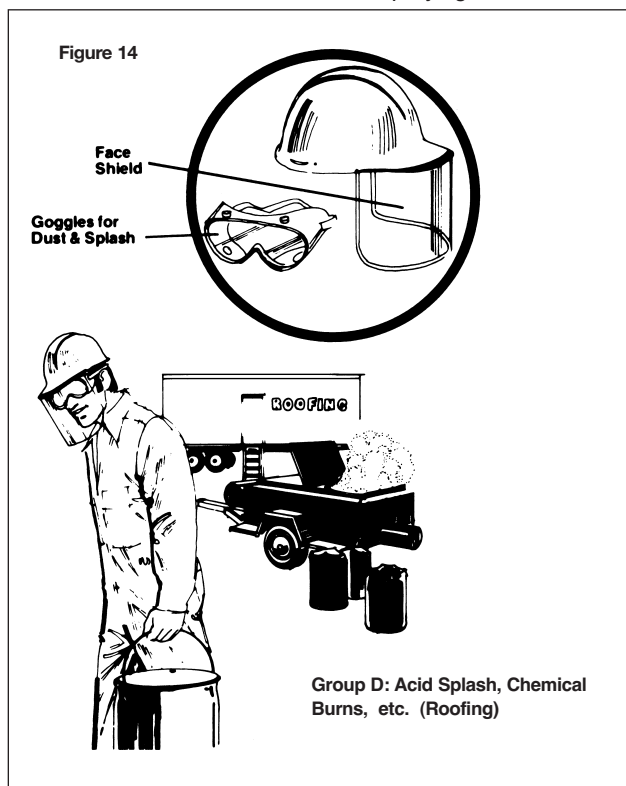


Group D: Acid Splash, Chemical Burns, etc. (Figure 14)

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.



Group E: Abrasive Blasting Materials (Figure 15)

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 (Figure 16)

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:

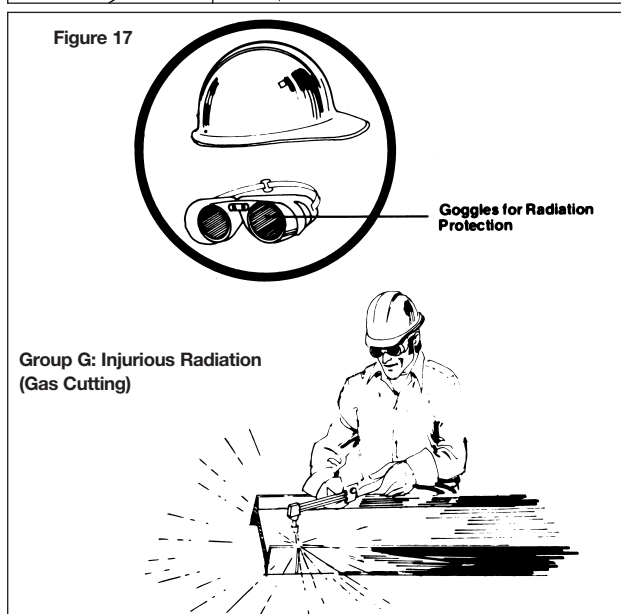
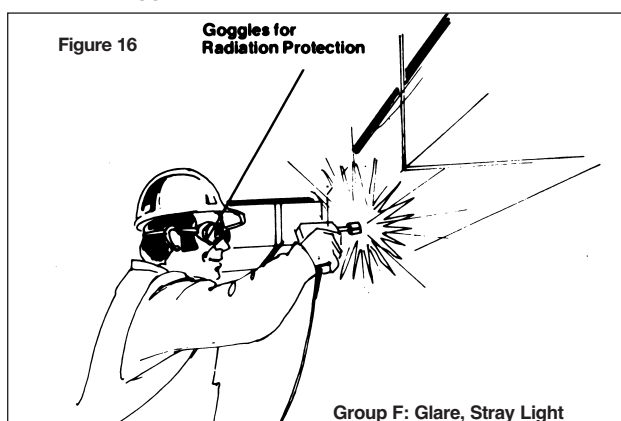
Goggles with filter lenses for radiation protection. See Table 1 for recommended shade numbers.

Group G: Injurious Radiation (Figure 17)

These are situations where only moderate reduction of visible light is required: for example, gas welding. Injurious radiation would result from looking directly at the welding operation.

Only eye protection recommended:

Goggles with filter lenses for radiation protection.



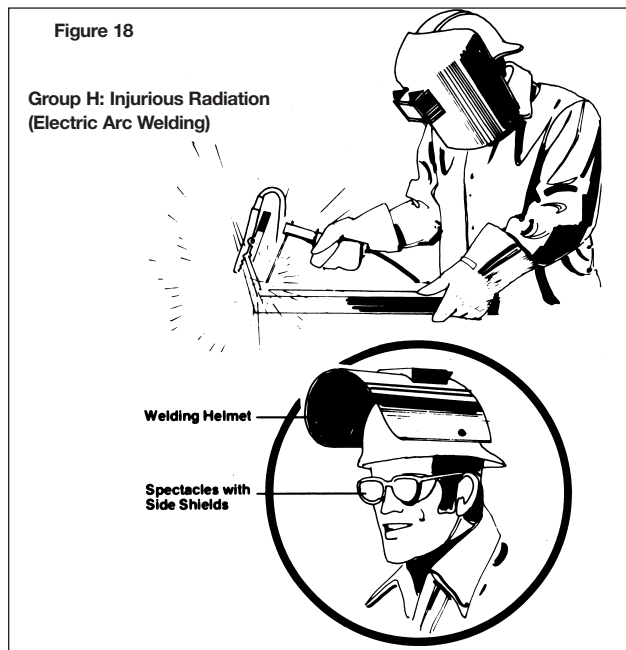
Note: The intensity of the flame and arc is lower in Group G than in Group H. For this reason, required filter shade numbers for this group are also lower. See Table 1.

Group H: Injurious Radiation (Figure 18)

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 1.



Injuries Associated with Construction Hazards

The cornea is the front layer of the eye and the first point at which light enters the eye; if light rays cannot pass through the cornea, vision is prevented. Injuries to the cornea that cause scarring, scratching, or inflammation 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 a red, watery, or pussy eye.

3. Heat

Heat can burn and severely damage the cornea.

4. Acid Splash

Acid splash and chemicals can burn the cornea, conjunctiva (white coat on the eye), and eyelid and possibly cause 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.

Correct eye protection, when matched to the hazard, can prevent or reduce the degree of any eye injury. However, once an eye injury has occurred, it is critical that the injury, no matter how small, be given immediate attention and first aid.

Eye protection can only protect against injury if it is worn continuously on site.

It is often the time when a worker removes eye protection while working near or passing by other hazardous activities on the job that an eye injury results. When it is necessary to remove eye protection, do so only 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.

Purchase of Protective Spectacles

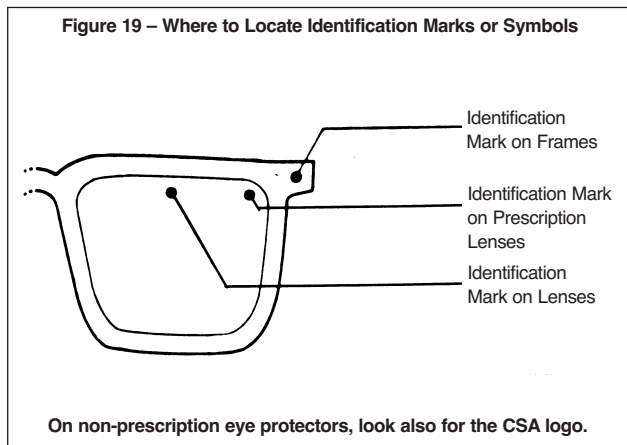
Protective spectacles are available with “plano” or non-prescription lenses and with prescription lenses.

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. Current glass lenses do not meet the impact requirements of CSA Standard Z94.3-07.

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 19).



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 which appears on the eye protector, the CSA logo will appear to indicate the eye protection meets the requirements of the CSA Z94.3-07 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 which indicates adherence to the American National Standards Institute (ANSI) Standard Z87.1-1989.

Fitting

Improper fit is the most common reason for resistance to 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 Adjustments are located on the top inside 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.

Care

Eye protectors in construction are subjected to many damage-causing hazards. Therefore, care is very important.

1. Lenses should be inspected regularly for pitting and scratches that can impair visibility.

2. Scratched or pitted lenses and loose frames or temples should be replaced or repaired as soon as possible with components from the original manufacturer.
3. Lenses should be cleaned with clear water to remove abrasive dust—cleaning dry lenses can scratch the surface.
4. Anti-fog solutions can be used on glass or plastic lenses.
5. Frames should be handled with care and checked daily for cracks and scratches.
6. Eye protectors should never be thrown into tool boxes where they can become scratched or damaged.
7. Cases should be provided and used to protect spectacle lenses when 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 impairment of vision.

Contact lenses are also difficult to keep clean when they have to be removed or inserted since there are seldom suitable washing-up facilities on a jobsite.

It is recommended that contact lenses not be worn on construction sites.

However, in cases where contact lenses must be worn to correct certain eye defects, workers should obtain written permission from their ophthalmologist or optometrist indicating the necessity of wearing contact lenses in order to function safely at work. In these cases eye protection, preferably cover goggles, must be worn with the contact lenses.

Table 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	Babbling, 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														

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. Courtesy Canadian Standards Association