BRITISH STANDARD

BS 7028:1999

Eye protection for industrial and other uses — Guidance on selection, use and maintenance

ICS 13.340.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee PH/2, Eye protection, to Subcomittee PH/2/2, Industrial eye protectors, upon which the following bodies were represented:

Electricity Association
Federation of Manufacturing Opticians
Glass & Glazing Federation
Institute of Mechanical Engineers
Manufacturing Science Finance
Personal Safety Manufacturers' Association
Royal College of Ophthalmologists
Welding Institute
HSE

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Contents

Foreword

This revision of BS 7028:1988 is based on CEN Technical Report 13464, *Eye protective equipment — Guide to selection, use and maintenance of occupational eye and face protectors*, which was itself partly based on BS 7028:1988 which is withdrawn. BS 7028 has been revised to satisfy the demand for a guide to the selection, care and maintenance of eye-protection equipment, taking acount of existing British Standards for such equipment.

Although particularly applicable to industry, this British Standard is also relevant to others, for example in educational establishments and the field of "do-it-yourself" activities, who need to select and use eye-protection.

In Great Britain, the legal requirements specifically governing the use of eye protection are contained in the Personal Protective Equipment at Work Regulations 1992 (SI 1992 No 2966, as amended by SI 1996 No 3039) [1], which are made under the Heath and Safety at Work etc. Act 1974[2].

Depending on the work being undertaken, there are also legal requirements for eye protection included in the general duties on personal protective equipment contained in the Control of Substances Hazardous to Health Regulations 1994 (SI 1994 No 3246) [3].

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 23 and a back cover.

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1 Scope

This British Standard gives guidance and background information on occupational eye- and face-protectors.

It includes the following information:

— an explanation and details of the relevant British Standards relating to occupational eye- and face-protectors;

— information to provide a basic understanding of the classification of hazards to the eye encountered in industrial and other occupational situations;

— an explanation and classification of the various types of eye- and face-protectors and a list of their various characteristics and protection capabilities;

— guidance on the selection, care and maintenance of occupational eye- and face-protectors.

It relates to all types of personal eye- and face-protectors used against various hazards encountered in industry, commerce, laboratories, education establishments, DIY activities, etc. that can damage the eye or impair vision with the exception of ionizing radiation such as X-rays and low temperature infrared (IR) radiation.

This British Standard does not include guidance on the use of sport, leisure or vehicular eye-protectors.

This British Standard is neither a whole nor partial substitute for a professional risk assessment which is an essential element of any safety eyewear selection exercise.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this (part of this) British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS EN 165, *Personal eye-protection — Vocabulary.*

BS EN 166, *Personal eye-protection — Specifications.*

BS EN 167, *Personal eye-protection — Optical test methods.*

BS EN 168, *Personal eye-protection — Non-optical test methods.*

BS EN 169, *Personal eye-protection — Filters for welding and related techniques — Transmittance requirements and recommended utilization.*

BS EN 170, *Personal eye-protection — Ultraviolet filters — Transmittance requirements and recommended use.*

BS EN 171, *Personal eye-protection — Infrared filters — Transmittance requirements and recommended use.*

BS EN 172, *Personal eye-protection — Sunglare filters for industrial use.*

BS EN 175, *Personal protection — Equipment for eye and face protection during welding and allied processes (excluding hoods).*

BS EN 207, *Personal eye-protection — Filters and eye-protection against laser radiation.*

BS EN 208, *Personal eye-protection — Eye-protectors for adjustment work on lasers and laser systems.*

BS EN 379, *Specification for welding filters with switchable luminous transmittance and welding filters with dual luminous transmittance.*

BS EN 1731, *Mesh type eye and face protectors for industrial and non-industrial use against mechanical hazards and/or heat.*

BS EN ISO 8980-1, *Ophthalmic optics — Uncut finished spectacle lenses — Specification for single vision and multifocal lenses.*

BS EN ISO 8980-2, *Ophthalmic optics — Uncut finished spectacle lenses — Specification for progressive power lenses.*

3 Overview of the referenced standards

A brief overview of relevant standards is given in Table 1.

4 Hazards to the eye encountered in occupational environments

4.1 Introduction

The fragile and vulnerable human eye is particularly prone to damage from the following three main hazard classifications encountered in occupational applications:

— mechanical;

— chemical;

— radiation.

Circumstances where two or more of these hazards are present either simultaneous or concurrently can occur. It is therefore essential to gain an appreciation of all the potential hazards that can be encountered in the working environment.

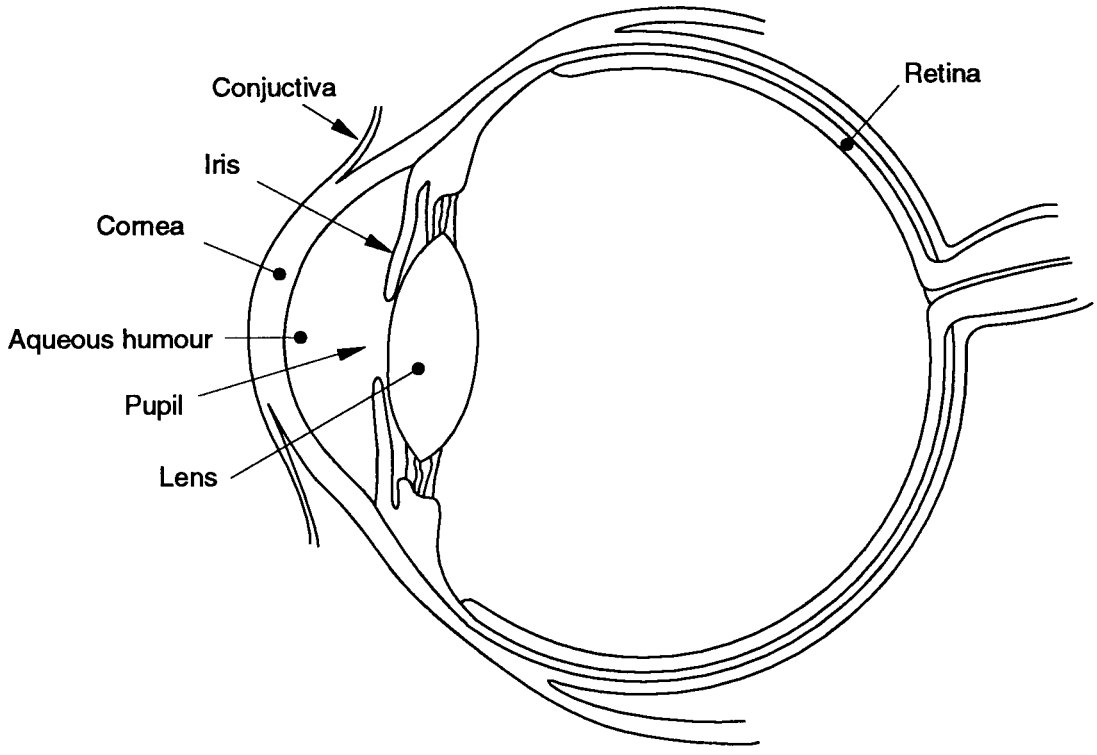
The damaging effects on the human eye that can arise from the various hazards are numerous and complex and range in severity from minor irritation to total blindness. To help explain these effects, discussed in the following clauses, a sectional diagram of the eye, highlighting the principal components, is shown in Figure 1.

Table 1 — Scope and content of occupational eye-protection standards

Standard	Scope and content
BS EN 165 Vocabulary	Provides a list of optical and technical terms found in European eye-protection standards and gives a brief informative definition of each term
BS EN 166 Specifications	Contains construction and performance specifications together with marking requirements for industrial/occupational eye-protectors, including protective spectacles, goggles, eyeshields and faceshields. Performance requirements are given for optical properties such as refractive powers, transmittance and diffusion of light, and mechanical properties such as robustness, temperature stability, ignition resistance, and resistance to molten metals, dust, liquid splashes, gases, short circuit electric arc and high speed particles
BS EN 167 Optical test methods	Describes the various optical test methods specified in BS EN 166 and other eye-protection performance standards
BS EN 168 Non-optical test methods	Describes the various non-optical test methods specified in BS EN 166 and other eye-protection performance standards
BS EN 169 Filters for welding and related techniques — Transmittance requirements and recommended utilization	Details transmittance requirements for welding filters against UV, visible and IR radiation. Contains recommendations for the selection of filters when using the various different types of welding equipment.
BS EN 170 Ultraviolet filters. Transmittance requirements and recommended use	Details transmittance requirements for filters against UV radiation. Contains recommendations for the selection of UV filters against the various sources and types of UV radiation.
BS EN 171 IR filters. Transmittance requirements and recommended use	Details transmittance requirements for filters against IR radiation. Contains recommendations for the selection of IR filters against the various sources and types of IR radiation.
BS EN 172 Sunglare filters for industrial use	Details transmittance and other requirements for filters against sunglare (visible glare) radiation
BS EN 175 Equipment for eye and face protection during welding and allied processes (excluding hoods)	Contains construction and performance specifications for welding protectors, including spectacles, goggles, faceshields and hand-held shields. Performance requirements are given for area of coverage, heat resistance, robustness, etc. The welding equipment described is intended for use with welding filters defined in BS EN 169 and BS EN 379
BS EN 207 Filters and eye-protectors against laser radiation	Details transmittance requirements and mechanical requirements for filters and mechanical requirements for complete eye-protectors for use against the various types of laser radiation
BS EN 208 Eye-protectors for adjustment work on lasers and laser systems	Details transmittance and other requirements for eye-protectors for use when adjusting or servicing visible lasers and laser systems
BS EN 379 Specification for welding filters with switchable luminous transmittance and dual luminous transmittance	Details transmittance and other requirements for welding filters which have two components (light and dark) and opto-electric filters which can be switched from one shade to another, either manually or automatically
BS EN 1731 Mesh type eye and face protectors for industrial and non-industrial use against mechanical hazards and/or heat	Contains construction and performance specifications for mesh type eye-protectors as used principally in the forestry, metal processing and steel industries. Types of mesh type eye-protectors are defined (spectacles, goggles and faceshields). Performance requirements are given for area of coverage, mesh size, heat resistance, robustness, etc.

Table 1 — Scope and content of occupational eye-protection standards *(continued)*

Standard	Scope and content
BS EN ISO 8980-1 Ophthalmic optics — Uncut finished spectacle lenses Specification for single vision and multifocal lenses	Specifies requirements for the optical and geometrical properties for uncut finished single-vision and multifocal spectacle lenses.
BS EN ISO 8980-2 Ophthalmic optics — Uncut finished spectacle lenses Specification for progressive power lenses	Specifies requirements for the optical and geometrical properties for uncut finished progressive spectacle lenses.
BS EN 60825-1 Safety of laser products Part 1 Equipment classification, requirements and users guide	Describes minimum requirements for safe working levels. Classifies lasers and laser products according to their degree of hazard, requirements for user and manufacturer to establish procedures and supply information.



Key

1 Conjunctiva
2 Iris
3 Cornea
4 Aqueous humour
5 Pupil
6 Lens
7 Retina

Figure 1 — The human eye

4.2 Mechanical hazards

4.2.1 *Sources*

Mechanical operations pose the most obvious sources of danger where damage to the eye can occur from flying debris, collision with static objects, ingress of fine particles, abrasion from fibrous materials or foliage and burns from hot liquids and molten solids.

In engineering machinery operations, sharp swarf from the component or a broken tool tip can readily become airborne at high velocity. In metal foundries and steel working the potential for molten metal splash is present, and in most working environments there are risks from falling objects and encounters with sharp corners that present further opportunity for damaging the eye.

In quarrying work and the construction industry there are obvious risks from flying chippings, and dust clouds. Similar hazards exist in mining operations, stone-masonry, sculpting and building repair.

Forestry and landscaping operations present a range of potential hazards from sharp foliage, "kick-back" from chain saws and flying fragments from broken power tools and machinery.

Exploding flasks in laboratories, dust clouds generated during automobile sanding operations and grit generated by shot blast operations are other examples of mechanical hazards which are common causes of eye injury.

4.2.2 *Effects*

The damage that can be caused to the eye by mechanical hazards ranges from mild irritation from ingress of fine dust to total loss of sight due to high velocity/high mass impacts or major, direct encounter with molten metals.

The cornea of the eye can easily be scratched by fine dust particles. This can result in discomfort or soreness lasting for a few minutes or several days depending on the severity of the abrasion. More severe damage to the cornea will result in clouded vision.

Sharp flying objects of sufficient mass and speed can easily penetrate the cornea to injure the iris and the lens itself. Physical damage to the lens and its associated muscles can result in permanent loss of focus.

Minor ingress of foreign matter can be readily dispersed by fluid secreted by the tear ducts whereas larger amounts will require dispersal by eye baths or other more intensive remedies conducted within a specialized medical environment.

4.3 Chemical hazards

4.3.1 *Sources*

As with mechanical hazards, the sources of chemical hazards are numerous and include very fine powders, aerosols, liquids, fumes, vapours and gases.

Chemical hazards can be less immediately obvious than mechanical hazards; for example, fine cement dust entering the eye in small quantities may not present a serious mechanical hazard but the strong alkaline bias of such materials can cause severe corneal burns.

Many insecticides used in crop spraying and generated in aerosol form pose an obvious hazard to agricultural workers. Paint spraying, varnishing and many other lacquering and treatment processes involve chemicals generated in aerosol form. Even if the base substance itself is harmless it could be carried by a more damaging chemical solvent.

The hazards associated with liquid chemicals are usually more obvious than from aerosols, fumes or gases and principally relate to splashes from containers during decanting and mixing, particularly where uncontrolled mixing leads to boiling by exothermic reaction.

Smoke and fumes generated by combustion are another potential cause of eye irritation and other more serious damage. The number of vapours and gases that can have a harmful effect on the eye is extensive and includes such common industrial use substances as acetone, chlorine, formaldehyde, hydrogen sulfide, sulfur dioxide and toluene.

Fume hazards are visible and warn of their presence whereas many harmful vapours and gases are invisible. Apart from leakages from containers and pipework, hazards also exist from vaporization of liquid chemicals during decanting, mixing and disposal.

Finally, biological hazards in the medical and dental environment related to splashes of blood and body tissue containing viruses are another danger that are broadly classified as a chemical hazard.

4.3.2 *Effects*

Liquid splashes of strong acids and alkalis can cause serious eye burns even blindness. Even minute splashes or fine aerosol spray of such substances can cause irritation or conjunctivitis.

Fuel vapours and certain hydrocarbons can cause a reduction of the oxygen content in the natural fluids in the eye leading to a condition known as corneal dystrophy that causes inflammation of eye and inner surface of the eye-lids.

Exposure to certain other chemicals can cause inflammation of the optic nerve paths, a condition known as optical neuritis.

Conjunctivitis can also be caused by allergic reactions to many chemical substances, pollens, and biological agents.

4.4 Radiation hazards

4.4.1 *The electromagnetic spectrum*

Table 2 shows a diagrammatic representation of the electromagnetic spectrum, which is broken down into a number of component parts or radiation bands. Each band merges into the next and cannot be separated as rigidly as the diagram suggests. The effects that the differing types of radiation produces depends significantly on the wavelength of the radiated wave.

Laser beams are not separately identified on the diagram as these fall at various wavelengths within the optical radiation spectrums and are high-energy beams of very narrow bandwidth.

This British Standard covers only eye-protectors against optical radiation [ultra violet (UV), visible and infrared (IR)].

4.4.2 *Sources*

Optical radiation hazards encountered in industry and commerce are numerous, the most basic being visible glare from strong sunlight or artificial light. Outside the visible spectrum optical radiation hazards include IR radiation, UV radiation, and laser beams.

Welding operations, both gas and electric, are a potent source of UV and IR radiation as well as visible glare.

Processes and plant that generate heat, such as steel-making furnaces, glass blowing and welding all generate potentially harmful IR radiation.

At the other end of the visible spectrum short wave UV emissions are associated with such sources as dental curing lamps, welding operations and mercury or xenon discharge lamps.

Lasers are being increasingly used in commerce and industry, for applications such as metal processing, optical alignment and medical surgery. Hazards can arise from accidental exposure to direct radiation or to stray radiation (diffused or reflected) during repair or servicing.

Much concern has been expressed in recent years on the potential radiation hazards of visual display unit (VDU) screens. It is now accepted that there is no reliable evidence to suggest that such units present any significant risk to the structure or functioning of the human eye. Any possible problems stemming from use of VDU's relate principally to ergonomic factors.

4.4.3 *Effects*

Due to natural mechanisms of defence (tears, lid closure reflex, etc.), low overexposure to IR radiation has no harmful effects on the eyes.

Prolonged periods of time and repetitive high, overexposure to IR-A rays can have a long-term effect on the lens (glassblowers cataract, for example).

Exposure to sufficiently intense sources (solar viewing, laser, etc.) results in burns in the cornea (IR-B and C) or in the retina and the lens (IR-A).

Exposure to certain levels of UV rays results in an acute effect and painful inflammation of the cornea and conjunctivitis. This effect is typically associated with exposure to electric arc welding and is commonly known as arc-eye.

4.5 Summary of hazards and sources

Table 3 gives a brief summary of some of the common types and sources of industrial eye protection hazards. No list can be comprehensive, therefore it should not be used as a substitute for a professional risk assessment of the working environment.

5 Classification of occupational eye-protectors

5.1 General classification systems

5.1.1 *Introduction*

There are three principal classification systems for occupational eye-protectors as follows:

a) classification by intended use, e.g. laser eye-protectors;

b) classification by style, e.g. goggles; and

c) classification by ocular performance.

Subclauses **5.1.2** to **5.1.4** describes all these options and explains how the three systems need to be integrated to provide a definitive overall classification of occupational eye-protectors. Subclause **5.3** describes the marking systems for occupational eye-protectors.

Table 2 — The electromagnetic spectrum

Cosmic rays	Gamms and X-rays	Optical radiation							Microwaves and UHF	VHF rays
		UV-C	UV-B	UV-A	Visible	IR-A	IR-B	IR-C		
10^{-4}	100	280	315	380	780	1 400	3 000	10^{-6}	10^{-9}	$>10^{9}$

Table 3 — Hazards to the eye and sources of hazards encountered in occupational environments

Classification	Hazard (examples)	Source (examples)
Mechanical	Flying metal particles	Metal machinery, weld chipping, riveting, wire cutting, grinding
	Flying stone/mineral particles	Abrasive blasting, stone dressing, sculpting, grinding, rock drilling
	Flying wood/fibrous particles	Wood turning, tree felling, scrub clearance
	Coarse airborne dusts	Cement mixing, stone dressing, wood sawing, orbital sanding, grain storing, flour milling, coal mining/processing
	Molten metal splash	Metal pouring, metal skimming, die casting, metal flame cutting, soldering
	High pressure water	Water jet blasting
	Short circuit electric arc	Electrical installations and equipment
Chemical	Chemical splashes	Bleaching, battery filling, electrolytic plating, degreasing, paint stripping, chlorination processing, cement mixing
	Liquid aerosols	Crop spraying, paint/lacquer spraying, fumigating
	Steam jets	Leaking pipework, pressure vessel venting
	Fine dusts and powders	Cement mixing, wall sanding, lime spreading, powder coating
	Fumes, vapours and gases	Varnishing, adhesive bonding, exhaust gas analysis, welding/soldering, fumigation
	Biological agents/viruses	Veterinary work, dental surgery, first aid, medical research, waste management
Radiation	IR	Furnace work, metal pouring/smelting, metal casting, gas welding/brazing, flame cutting
	Visible glare	High temperature furnaces, high intensity artificial light, strong sunlight
	Ultra-violet	Electric arc welding, high energy discharge lamps, short circuit electric arcs dental curing lamps, strong sunlight, lacquer curing plant
	Laser	Laser measurement equipment laser cutting, stray beams from laser systems laser systems manufacture/repair

5.1.2 *Classification by intended use*

The intended use, or application, of an eye-protector may be used as an overall classification system. Within the available range of industrial eye-protection BS ENs there are a number of application categories as detailed in Table 4.

NOTE To assist further consideration of eye-protector classification, the eye-protectors cited in Table 4 can be conveniently placed in the following three categories:

— welding;

— laser; and

— other-use.

5.1.3 *Classification by style*

The many available styles of occupational eye-protectors can be conveniently classified into three principal categories as follows:

— spectacles;

— goggles; and

— faceshields.

Spectacles protect the eyes and offer limited protection to the orbital cavities. Goggles protect the eyes and orbital cavities and faceshields provide both eye and face protection.

General descriptions of spectacles, goggles and faceshields are given in Table 5.

5.1.4 *Classification by ocular performance*

In addition to classification according to use and style, eye-protectors (mainly their oculars) may also be classified by their performance rating against various hazards encountered in use. These performance categories or ratings are determined by assessment in accordance with the various BS ENs cited in Table 4 and denoted by specific markings on the frame and/or ocular (see **5.3** — Marking of occupational eye-protectors).

Performance categories are as follows:

a) corrective effect: prescription lenses or non corrective lenses;

b) optical class: class 1, 2 or 3;

c) filtering effect: scale number (code number and shade number);

d) resistance to surface damage;

e) resistance to fogging;

f) enhanced reflectance in the infrared.

Table 4 — Classification of industrial eye-protectors by intended use

Eye-protector intended use category	Applicable standard[a]
Basic use	BS EN 166
Impact	BS EN 166, BS EN 1731
Liquids	BS EN 166
Coarse dust	BS EN 166
Gas and fine dust	BS EN 166
Solar radiation	BS EN 172, BS EN 166
IR radiation/radiant heat	BS EN 166, BS EN 171, BS EN 1731
UV radiation	BS EN 166, BS EN 170, BS EN 169
Welding radiation	BS EN 169, BS EN 175, BS EN 379, BS EN 166
Laser radiation	BS EN 207, BS EN 208, BS EN 166
Molten metal	BS EN 166
Short circuit electric arc	BS EN 166

[a] See Table 1 for title, scope and content.

Table 5 — Features of eye-protector styles

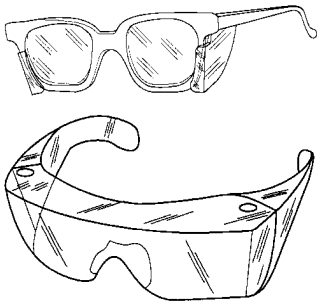
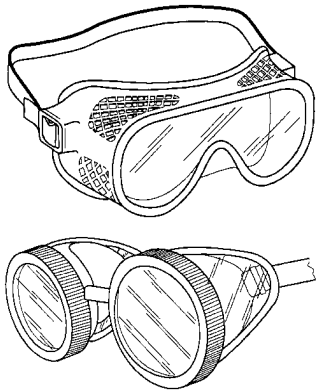
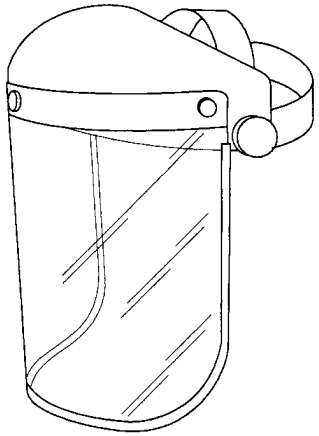
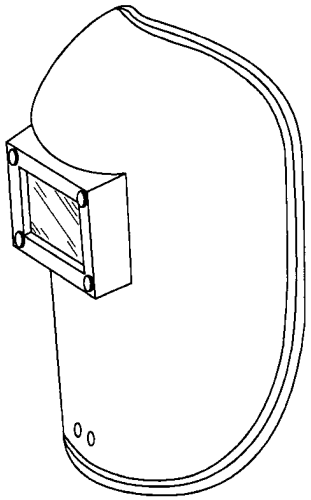
Spectacles	**Twin type ocular**	**Single ocular (eyeshield)**
	Twin oculars held within conventional spectacle-type frame. Usually held in position by side-arms. Usually incorporates sideshields to provide lateral protection to orbital cavities. Some designs available with corrective oculars. May be fitted with filtering oculars for limited.	Single-piece ocular, usually with check and brow projections for additional protection. Usually incorporate deep integrally moulded side-arms to provide lateral protection. Some styles may be worn over normal corrective spectacles. Oculars may incorporate filtering effect for limited protection against UV, IR and sunglare radiation.
Goggles	**Box type**	**Cup type**
	Single ocular held in malleable frame. Usually held in position by headband. Provides complete enclosure to orbital cavities. May incorporate direct or indirect ventilation. If suitable frames are used together with welding Oculars then protection against welding radiation is possible. Larger styles may be worn over corrective spectacles. Mesh oculars may be available.	Twin oculars held in opaque cup frames. Filtering effect oculars usually fitted for protection against welding radiation. May incorporate direct or indirect ventilation. Cannot be worn over protective spectacles. Cover lenses may be fitted to protect oculars from weld spatter. Mesh oculars may be available.

Table 5 — Features of eye-protector styles *(continued)*

Faceshields	Faceshield	Welding faceshield
 	Single piece sheet or moulded visor attached to a brow guard with adjustable headband. Visor may also be attached via a carrier to a safety helmet. Visors available with filtering effect for limited protection against optical radiation. Provides protection to all or part of the face. May be worn over corrective spectacles. Mesh type visors available.	May be fitted with a headband for wearing on the head, or hand held. May also be fitted to a safety helmet via a suitable carrier. Opaque screen incorporates a fixed or flip-up aperture to accommodate welding filters. Provides protection to all or part of face. May be worn over corrective spectacles.

5.1.5 *Summary*

To provide a complete classification of an eye-protector it is necessary to specify the intended use, the style and the performance category. It may also be necessary to separately specify the type of ocular, which may be clear, welding, UV, IR, sunglare or mesh. The following list illustrates the various elements of the classification system.

a) Intended use: welding, laser, or other.

NOTE 1 "Other" means one or more of basic use, impact, liquids, coarse dust, gas and fine dust, solar radiation, IR radiation/radiant heat, UV radiation, molten metal and short circuit electric arc.

b) Style: spectacle, goggle, or faceshield.

c) Type of ocular: clear, filter effect, or mesh.

NOTE 2 "Clear" means without filtering effect.

d) Ocular performance comprising**:** corrective effect, optical class; scale number; resistance to surface damage; resistance to fogging; enhanced reflectance in the infrared.

5.2 Detailed performance classification of occupational eye-protectors

5.2.1 *Introduction*

The previous subclause described a general classification system for occupational eye-protectors and highlighted the principal elements of intended use, style and ocular performance. This clause of this British Standard details more precisely the complete eye-protector performance categories available for welding, laser and other applications.

5.2.2 *Eye-protectors other than welding and laser ("other use" eye-protectors)*

5.2.2.1 *General*

Eye-protectors for use in applications other than welding and laser are specified in BS EN 166 which defines various performance categories relating to optical and non-optical properties. Special types of other use eye-protectors, known as mesh type eye-protectors, are detailed in BS EN 1731.

5.2.2.2 *Basic requirements for "other-use" eye-protectors*

All "other-use" eye-protectors are required to conform to certain basic requirements. These basic requirements are detailed in BS EN 166 (BS EN 1731 for mesh type eye-protectors) and relate to the oculars (optical class, dimensions, diffusion of light, optical quality and robustness) and the complete eye-protector (increased robustness, resistance to ageing, resistance to corrosion and resistance to ignition).

Mesh type eye-protectors are required to conform to basic requirements related to mesh size, resistance to corrosion, resistance to ignition, luminous transmittance, reflectance and robustness.

Apart from basic requirements, other-use eye-protectors are required to conform to additional particular requirements as described in the remainder of this subclause.

5.2.2.3 *Filtering effect of oculars*

The filtering effect of an ocular is categorized by its transmittance of electromagnetic energy over specified UV, visible and IR wavelengths. The transmittance values are transposed into a scale number which is required to be marked on all oculars with filtering effect. Clear oculars have no scale number and are defined as those oculars with a luminous transmittance value greater than 74.4 %. The scale number for filters increases as the transmittance decreases; i.e. the higher the scale number the higher the level of protection against optical radiation.

Scale numbers for oculars with filtering effect are shown in BS EN 166.

The transmittance values relating to the scale numbers are contained in BS EN 170 (UV filters), BS EN 171 (IR filters) and BS EN 172 (sunglare filters).

5.2.2.4 *Optical class of mounted oculars*

Oculars without corrective effect, in reality, can have a degree of refractive power resulting from manufacturing tolerances.

The permissible deviations for mounted oculars without corrective effect are contained in BS EN 166.

Three optical classes are defined, class 1 is superior to class 2 by virtue of smaller allowable deviations. Class 3 oculars have greater allowable deviations than class 2 and are not intended for long term use.

The permissible deviations for the refractive powers of oculars with corrective effect are specified in BS EN ISO 8980-1 and BS EN ISO 8980-2. Oculars which conform to these specifications are classified as optical class 1. For optical class 2 the deviations may be 0.06 m^{-1} higher than for class 1. There is no optical class 3 specification for oculars with corrective effect.

5.2.2.5 *Additional performance classification related to particular hazards and additional properties*

"Other-use" eye-protectors may also be classified for use against particular hazards (field of use) and/or in relation to particular additional characteristics. These classifications are denoted by a symbol marked on the frame and/or ocular.

Not all styles of eye-protector can be specified for all fields of use; for example, it is not permissible to specify a spectacle for protection against a potential molten metal hazard.

Table 6 defines the performance classification relating to field of use (hazard) and additional properties.

Table 6 — Classification of occupational eye-protectors for particular fields of use and additional performance characteristics (excludes welding and laser eye-protectors)

Field of use (hazard)/additional Characteristics	Symbol	Position of symbol	Applicable style of eye-protector (spectacle, goggle, faceshield)	Availability of mesh type eye-protector
Increased robustness	S	Ocular only	All types	Yes
High speed particles, low energy impact	−F	Ocular and frame	All types	Yes
High speed particles, medium energy impact	−B	Ocular and frame	Goggles and faceshields only	Yes
High speed particles High energy impact	−A	Ocular and frame	Faceshields only	Yes
Liquid splashes	3	Frame only	Faceshields only	No
Liquid droplets	3	Frame only	Goggles only	No
Coarse dust particles	4	Frame only	Goggles only	No
Gas and fine dust particles	5	Frame only	Goggles only	No
Short circuit electric arc	8	Ocular only	Faceshields only	No
Molten metals and hot solids	9	Ocular and frame	Goggles and faceshields only	No
Resistance to surface Damage by fine particles (oculars only)	K	Ocular only	All types	No
Resistance to fogging (oculars only)	N	Ocular only	All types	No
Radiant heat (mesh type only)	G	Frame and mesh	Faceshields only	Yes
UV, IR, Solar radiation	None	—	All types	No

5.2.3 ***Welding eye-protectors***

5.2.3.1 *General*

Requirements for welding eye-protectors are specified in BS EN 175. Welding eye-protectors may be spectacles, goggles, faceshields or handshields, and are fitted with welding oculars as defined in BS EN 169 (single shade) or BS EN 379 (switchable or dual shade).

5.2.3.2 *Basic requirements for welding eye-protectors*

All welding eye-protectors need to conform to certain basic requirements detailed in BS EN 175. These requirements include dimensions, area of coverage, robustness, resistance to damage when dropped, light reflectance, light attenuation, electrical insulation, resistance to ignition, resistance to corrosion and maximum mass.

5.2.3.3 *Oculars for use with welding eye-protectors*

Welding eye-protectors are fitted with filtering effect oculars (filters) as defined in BS EN 169 or BS EN 379. These filters are classified by a distinct scale number that is related to the luminous transmittance. Each scale number has specific requirements against UV, visible and IR radiation. The scale number of these filters comprises the shade number only and ranges from 1.2 to 16 as defined in BS EN 169.

In addition to the above, there are special requirements for spectral transmittance between certain wavelengths and also when welding with flux.

Filters with switchable or dual luminous transmittance are defined in BS EN 379. The scale numbers are as defined in BS EN 169 but the filter will have a dual scale number. The difference between the two numbers (for light and dark shades) is required to be no greater than 5 for dual luminous transmittance filters and no greater than 9 for switchable luminous transmittance filters. If the transmittance is switchable from one shade to another, the switching time is required to fall within certain limits as detailed in BS EN 379.

5.2.3.4 *Optional higher specification for welding eye-protectors*

Welding eye-protectors may be specified for use against additional hazards (fields of use). These fields of use are high speed particles, molten metal and water immersion. These classifications are denoted by a particular symbol marked on the frame. Not all styles of welding eye-protector may be specified for all optional fields of use; Table 7 describes the additional details.

5.2.4 ***Laser eye-protectors***

5.2.4.1 *General*

Laser eye-protectors are divided into two distinct classifications:

— laser eye-protectors against laser radiation in the spectral range 180 nm to 1,000,000 nm (defined in BS EN 207); and

— laser eye-protectors for adjustment work on laser systems where hazardous radiation occur in the range 400 nm to 700 nm.

5.2.4.2 *Eye-protectors for protection against laser radiation* (BS EN 207)

Classification of laser eye-protectors is by means of a scale number related to spectral transmittance, laser power and energy density as detailed in BS EN 207.

Other general requirements relating to laser eye-protectors are as follows:

— luminous transmittance;
— stability to laser radiation;
— quality of material and surface;
— stability to UV and temperature;
— ignition;
— field of vision;
— mechanical strength (filters and frames).

5.2.4.3 *Eye-protectors for adjustment work on lasers and laser systems* (BS EN 208)

Classification of laser adjustment eye-protectors is in the form of a scale number related to spectral transmittance and laser power as detailed in EN 208.

Other general requirements relating to laser adjustment eye-protectors are as follows:

— luminous transmittance;
— stability to laser radiation;
— quality of material and surface;
— stability to UV and temperature;
— ignition;
— field of vision;
— mechanical strength (filters and frames).

5.3 Marking of occupational eye-protectors

5.3.1 ***General***

Marking regimes for occupational eye-protectors are contained within the relevant standards for occupational (other-use) eye-protectors (BS EN 166 and BS EN 1731), welding eye-protectors (BS EN 175 and BS EN 379) and laser eye-protectors (BS EN 207 and BS EN 208). This subclause summarizes the marking requirements. For precise details the relevant BS EN should be referred to. Any other quality marks which are included should be distinct from standards marking. A certification mark, where applicable, may be included with the ocular marking in accordance with the requirements of the certification body. A certification mark, where applicable, may be included with the frame marking in accordance with the requirements of the certification body.

Table 7 — Classification of welding eye-protectors for optional fields of use

Field of use (hazard)	Symbol	Applicable type (Spectacle, goggle, faceshield, handshield)
Increased robustness	S	All types
High speed particles Low energy impact	F	All types
High speed particles Medium energy impact	B	Goggles and faceshields only
Molten metals and hot solids	9	Goggles and faceshields only
Water immersion	W	Faceshields and handshields only

5.3.2 ***Other-use eye-protectors*** (BS EN 166)

5.3.2.1 *Oculars*

Oculars are marked separately from frames; the marking comprises a sequence of letters and numbers in a horizontal format on the ocular in the following order:

a) scale number (filters only);

b) identification of the manufacturer — letter or symbol;

c) optical class (except cover plates) — 1, 2 or 3;

d) symbol for increased robustness or impact energy (where applicable) S, F, B or A;

e) symbol for short circuit electric arc (where applicable): 8;

f) symbol for molten metal/hot solids (where applicable): 9;

g) symbol for resistance to surface damage by fine particles (where applicable): K;

h) symbol for resistance to fogging (where applicable): N.

Example:

3-2,5 X 1 S 9 N

In the above example

— 3-2,5 is the scale number comprising:

— the code number 3 (UV filters with good colour recognition);

— and shade number 2,5;

— X denotes the symbol of the manufacturer;

— 1 denotes optical, class 1;

— S denotes increased robustness;

— 9 denotes resistant to molten metals and hot solids; and

— N denotes resistant to fogging.

5.3.2.2 *Frames*

As with oculars, the marking on frames comprises a horizontal line of symbols, the sequence being as follows:

a) identification of the manufacturer — letter or symbol;

b) the number of the standard — EN 166 (or, as a minimum, the number 166);

c) applicable fields of use — in the order shown in Table 7;

d) symbol for resistance to high speed particles (where applicable).

Example:

X EN 166 3 4 9 -B

In the above example:

— X is the symbol of the manufacturer;

— 3 denotes resistance to liquids;

— 4 denotes resistance to large dust particles;

— 9 denotes resistance to molten metals and hot solids; and

— -B denotes resistance to high speed particles — medium energy impact.

5.3.2.3 *Eye-protectors where the frame and ocular form a single unit*

The marking of this type of ocular is placed on the frame and consists of the ocular marking as described in **5.3.2.1** followed by a hyphen and then frame marking as described in **5.3.2.2** but without the identification of the manufacturer as this is included with the ocular marking.

5.3.3 ***Mesh eye-protectors*** (BS EN 1731)

Mesh eye-protectors are marked in accordance with BS EN 166 but with an additional optional symbol "G" to signify resistance to radiant heat.

5.3.4 ***Welding eye-protectors***

5.3.4.1 *Filters (filtering effect oculars)* (BS EN 169 and BS EN 379)

Welding filters with single shade (BS EN 169) are marked in an identical manner to other-use oculars (BS EN 166). The scale number will comprise only the shade number.

A welding filter with dual shade (BS EN 379) will also be marked in this manner but with the single shade number replaced by both light and dark shade numbers (light numbers first) separated by a "+" symbol.

Welding filters with switchable shade number (BS EN 379) are also marked in the same format but with additional symbols detailed as follows.

a) The scale number symbols comprise the light shade scale number and dark shade scale number separated by an oblique stroke. Where the dark shade is manually controlled, the limits of the range of attainable scale numbers is marked, separated by a hyphen.

b) The diffused light class 1, 2 or 3 and conformity of luminous transmittance class is added to the optical class, separated by oblique strokes.

Example:

5/11 - 13 X 1/3/2 EN 379

The above marking denotes:

— a filter with a light shade of 5 switchable to a dark shade variable between 11 and 13;

— X denotes the manufacturers identification;

— 1 signifies optical class 1;

— 3 denotes the diffusion of light class; and

— 2 denotes the variation in luminous transmittance class.

5.3.4.2 *Frames* (BS EN 175)

Welding protector frames are marked with a horizontal sequence of symbols in the following order:

a) identification of manufacturer — symbol or letters;

b) the number of this standard — EN 175 (or, as a minimum, the number 175);

c) applicable fields of use — as shown in Table 6;

d) certification mark — if any;

e) mass in grams — where applicable (i.e. for hand-held shields of greater than 500 g mass).

Example:

X EN 175 9 -B 528

In the above example

— X is the identification mark of the manufacturer;

— EN 175 is the number of the standard;

— 9 denotes resistance to molten metals/hot solids;

— -B denotes resistance to high speed particles — medium energy impact; and

— 528 is the weight of the frame in grams.

5.3.5 ***Laser eye-protectors***

5.3.5.1 *Laser radiation eye-protectors* (BS EN 207)

Laser filters and frames are considered to be a single complete unit and therefore the marking is placed either on the ocular or on the frame.

The marking consists of a horizontal sequence of numbers and symbols in the following order:

a) test condition symbol for laser type — see the note below;

b) wavelength for which eye-protection gives protection — see note 2 below;

c) scale number;

d) manufacturers identification mark;

e) certification mark — if applicable.

f) Increased robustness or high speed particle symbol in accordance with EN 166 — if applicable.

NOTE 1 The relevant test condition symbols for various laser types are as follows:

— D: continuous wave lasers;

— I: pulsed lasers;

— R: giant pulsed lasers;

— M: mode-coupled pulse lasers.

NOTE 2 A single wavelength or a wavelength range in nm shall be stated, depending on the capabilities of the filter.

Example:

DR 630–700 L8 X S

In the above example:

— DR signifies the protector is suitable for continuous wave and giant pulsed lasers only within a wavelength range of 630 nm to 700 nm;.

— L8 is the scale number;

— X the manufacturers identification symbol;

— S indicates the ocular has increased robustness capability as defined in BS EN 166.

5.3.5.2 *Laser adjustment eye-protectors* (BS EN 208)

Laser adjustment filters and frames are considered to be a single complete unit and thus the marking is placed either on the ocular or on the frame.

The marking consists of a horizontal sequence of numbers and symbols in the following order:

a) maximum laser power (W);

b) maximum pulse energy (J);

c) wavelength for which the eye-protector is specified — see Note 1 below;

d) scale number;

e) manufacturers identification mark;

f) certification mark — if applicable;

g) increased robustness or high speed particle symbol in accordance with BS EN 166 — if applicable.

NOTE 1 A single wavelength or a wavelength range in nm shall be stated, depending on the capabilities of the filter.

Example:

10W 2×10^{-3} J 500–550 R4 X S

In the above example:

— 10W signifies the maximum laser power;

— 2×10^{-3} J denotes the maximum pulse energy;

— 500–550 denotes a wavelength range of 500 nm to 550 nm;

— R4 is the scale number;

— X is the manufacturers identification symbol;

— S indicates that the ocular has increased robustness capability as defined in BS EN 166.

6 Selection of occupational eye-protectors

6.1 Introduction

NOTE The information contained in this clause is for guidance only.

The selection of appropriate and suitable eye-protectors for any given situation is of vital importance. If the procedure is not performed satisfactorily then the effect on the wearer could range from minor discomfort through minor injury to complete loss of sight.

It is the duty and responsibility of the employer (or self-employed person) to select suitable eye-protection; the responsibility cannot be passed to the manufacturer, supplier or employee. To maximize acceptance of Personal Protective Equipment (PPE) it is necessary to actively involve the end-user at all stages of the selection process. The duty of the manufacturer is to provide information to assist the employer in selecting the protector appropriate to the risks encountered.

The first duty of the employer is to perform a risk assessment that clearly defines the source and nature of all potential hazards. This analysis should be performed and recorded by a person or persons who are adequately trained and qualified to perform such duties. The risk assessment needs regular review and update at any time that relevant circumstances in the working environment change.

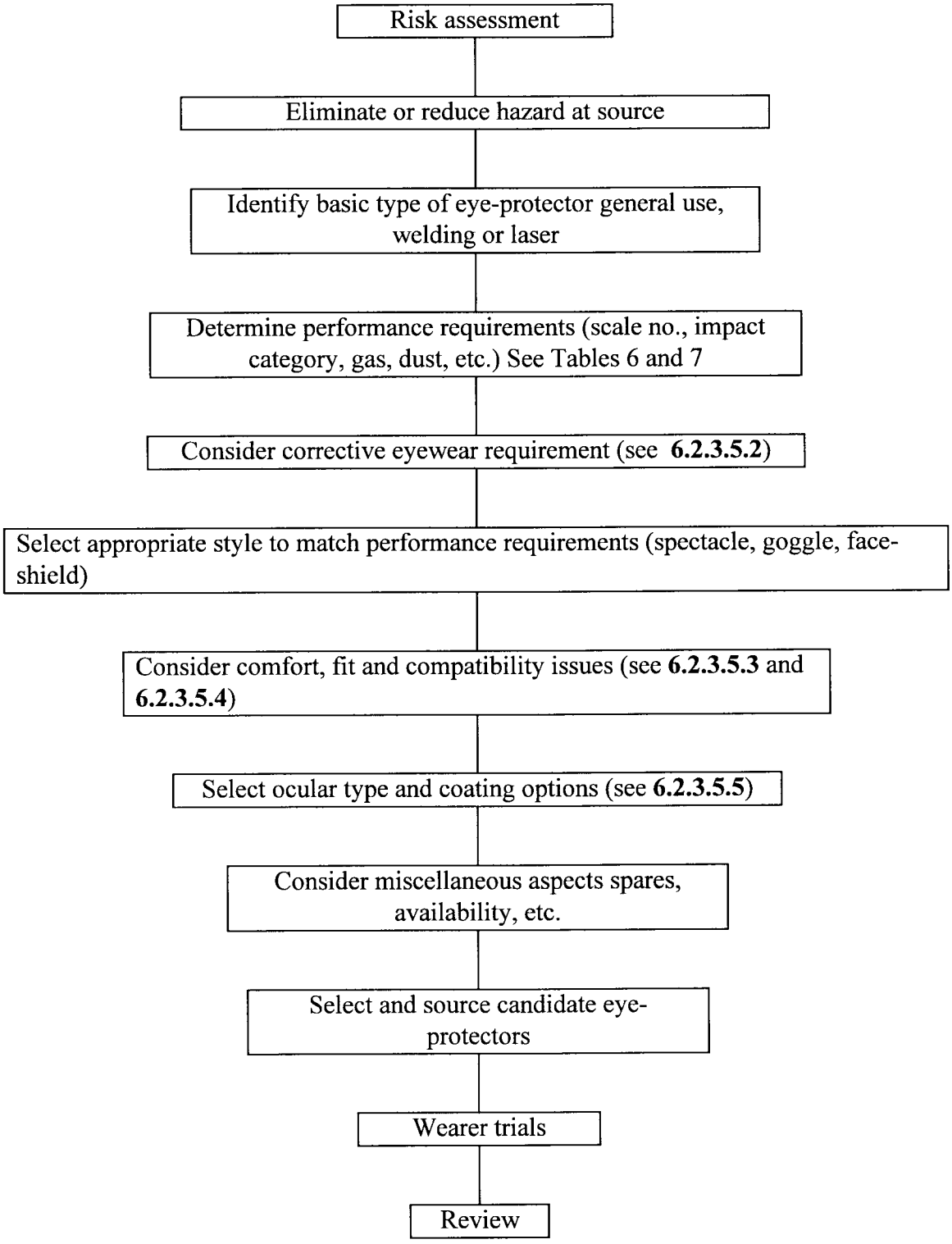


Figure 2 — Occupational eye-protector selection sequence

Having identified the hazard and assessed the risk, the next step is to consider and enact all practicable means of eliminating or reducing the source of the hazard. Personal eye-protectors are considered as a last resort in protecting the individual from hazards in the workplace. If the hazard cannot be eliminated, contained by screening, or reduced to a level which would not cause injury then suitable eye-protection needs to be considered and the selection process commenced.

The selection procedure is considered in greater detail in the remainder of this clause; the process elements and sequence are detailed in Figure 2.

6.2 Analysis of selection procedure

6.2.1 *Identification of hazard and basic eye-protector type*

Having determined that individual eye-protection is necessary, the risk assessment should be examined to determine the basic type of eye-protector required and whether or not other items of PPE are necessary. All significant risks need to be addressed at this stage.

a) If the hazard is identified as a welding process then a welding protector as specified in BS EN 175 is appropriate.

b) If the hazard is identified as laser radiation then a laser eye-protector as specified in BS EN 207/ BS EN 208 is appropriate.

c) If the hazard is mechanical, chemical and/or optical radiation other than welding or laser then an eye-protector as specified in BS EN 166/ BS EN 1731 is appropriate.

Once the basic type of eye-protector has been established the next stage of the selection process is to determine its required performance specification.

6.2.2 *Determination of performance requirements*

6.2.2.1 *Occupational eye-protectors other than welding and laser ("other-use" eye-protectors)* (BS EN 166/BS EN 1731)

There are a number of potential performance requirements that need to be determined when specifying eye-protectors. Table 7 shows the available fields of use. These are described in more detail in the following paragraphs.

High speed particles: three energy levels are available as follows:

Low energy (symbol -F)	Medium energy (symbol -B)	High energy (symbol -A)
Impact speed of a 6 mm diameter steel ball at 45 m/s	Impact speed of a 6 mm diameter steel ball at 120 m/s	Impact speed of a 6 mm diameter steel ball at 190 m/s

Liquid splashes: if the potential hazard is a splash of liquid, a liquid splash field of use may be specified. However, the analysis should also consider the hazardous nature of the liquid and the likely speed and volume of the released liquid.

Liquid droplets: if the liquid hazard is in the form of an aerosol or mist, a liquid droplet field of use will need to be specified. Again the hazardous nature of the liquid will need to be considered.

Large dust particles: this field of use is necessary to specify if the risk assessment shows that the wearer could be exposed to a level and type of dust which could cause irritation or damage to the eye. If the mass and velocity of the particles are sufficiently high, a high speed particle field of use may need to be specified.

Gas and fine dust particles: workers in an environment where gases, vapours, smoke, fumes and very fine particulate matter are present require an eye-protector with appropriate protection capabilities.

Short circuit electric arc: if this hazard is present, an assessment should be made of whether the BS EN 166 specification is both suitable and provides sufficient protection.

Molten metals and hot solids: this field of use relates to a protection capability against 100 g of molten grey iron at 1 450 °C and 38 g of molten aluminium at 750 °C projected under force onto the eye-protector, and resistance to penetration of a 6 mm diameter steel ball at 900 °C within 5 s to 7 s under its own weight. The risk assessment needs to produce evidence that such a field of use specification will be adequate to protect against the identified molten metal/hot solid hazard.

Radiant heat: if radiant heat is an identified hazard, a mesh face screen in accordance with BS EN 1731 may provide adequate protection; however, the nature of the hazard should be compared to the test parameters specified in BS EN 1731.

Eye-protectors may also have assigned additional optional performance requirements. If protection is required against optical radiation other than welding or laser, a filtering effect ocular in accordance with BS EN 170 (UV), BS EN 171 (IR) or BS EN 172 (sunglare) will need to be specified. The risk assessment will need to identify the nature and type of the radiation to enable a scale number to be selected. Recommendations for the selection of filters according to the nature and intensity of the radiation are given in the informative annex of each of these standards.

If the risk assessment shows that the eye-protector ocular could be subject to premature wear by the effect of fine particles, this field of use may be specified. Also, if it is considered that an ocular resistant to fogging would be of benefit then a suitable field of use category is available in BS EN 166.

6.2.2.2 *Welding eye-protectors* (BS EN 175)

To establish the performance requirements of a welding eye-protector requires knowledge of the relevant welding process. The principal performance requirements to define are the scale numbers of the required welding filters; these are detailed in relation to the specific welding process in the Tables 8, 9 and Table 10 (reproduced from BS EN 169).

In strong natural light it may be preferable to use a filter of one scale number higher.

For welders' assistants or persons in the vicinity of welding operatives rather than directly engaged, a filter of scale number 1, 2 to 4 may be sufficient, but this depends on the proximity to the operation. Extreme care is vital when specifying filters of a lower scale number than those indicated.

Other performance requirements that may need to be specified for welding eye-protectors are resistance to high speed particles and resistance to molten metals/hot solids. Further assessment details on these potential hazards are detailed in **6.2.2.1**.

6.2.2.3 *Laser eye-protection (*BS EN 207/BS EN 208)

For direct laser protection, laser eye-protectors that conform to BS EN 207 are required. The performance requirement of the laser eye-protector relates to the wavelength, power and energy of the laser beams. Once these have been determined the scale number of the protective filter can be specified and will range from L1 to L10 inclusive, as specified in BS EN 207.

For laser adjustment work, laser adjustment eye-protection that conform to BS EN 208 are required. The performance requirement of the laser adjustment eye-protector relates to the laser power and energy. Once these have been determined the scale number of the protective filter can be specified and will range from R1 to R5 inclusive, as specified in BS EN 208.

In addition to the above information it may also be necessary to specify the laser beam diameter and for pulsed lasers the energy per pulse, pulse duration and pulse frequency.

Further information on performance parameters and risk assessment can be found in BS EN 60825-1.

6.2.3 ***Selection of suitable eye-protectors***

6.2.3.1 *General*

The previous clauses have detailed the selection process for determining the basic type of eye-protector, welding, laser or other, and the performance requirements. The final stage of the selection process is to select a style of eye-protector that matches these requirements. It is possible that these requirements can be fulfilled by more than one style of eye-protector (spectacle, goggle or faceshield) and probable that many models from a variety of manufacturers will be available for consideration.

It is good practice to offer the wearer a wide selection of suitable eye-protectors and to carry out wearer trials to assess subjective parameters such as comfort, fit, aesthetic appeal, ease of maintenance, compatibility with other items of PPE, etc.

6.2.3.2 to **6.2.3.4** indicate the requirements of the relevant eye protection standards and should be used as a guide to discuss these more subjective aspects in greater detail.

6.2.3.2 *Occupational eye-protectors other than welding and laser ("ther-use" eye-protectors)*

As shown in Table 7, not all styles of eye-protection are available for all performance categories.

Spectacles should only be specified for low energy impacts as they are not so securely retained on the head as goggles and faceshields. Goggles are restricted to low and medium energy impact classification as it is considered that for high energy impact hazards, face protection is also required. Face-shields may be selected for all impact categories.

Liquid splash hazards require face protection and therefore spectacles and goggles are not acceptable. Liquid droplet hazards necessitate complete enclosure of the orbital cavities and therefore only goggles are suitable.

Table 8 — Scale numbers to be used for gas welding and brazing (see note)

Work	q = flow rate of acetylene, in litres per hour			
	$q \leq 70$	$70 < q \leq 200$	$200 < q \leq 800$	$q > 800$
Welding and braze welding of heavy metals[a]	4	5	6	7
Welding with emittive fluxes (notably light alloys)	4a	5a	6a	7a

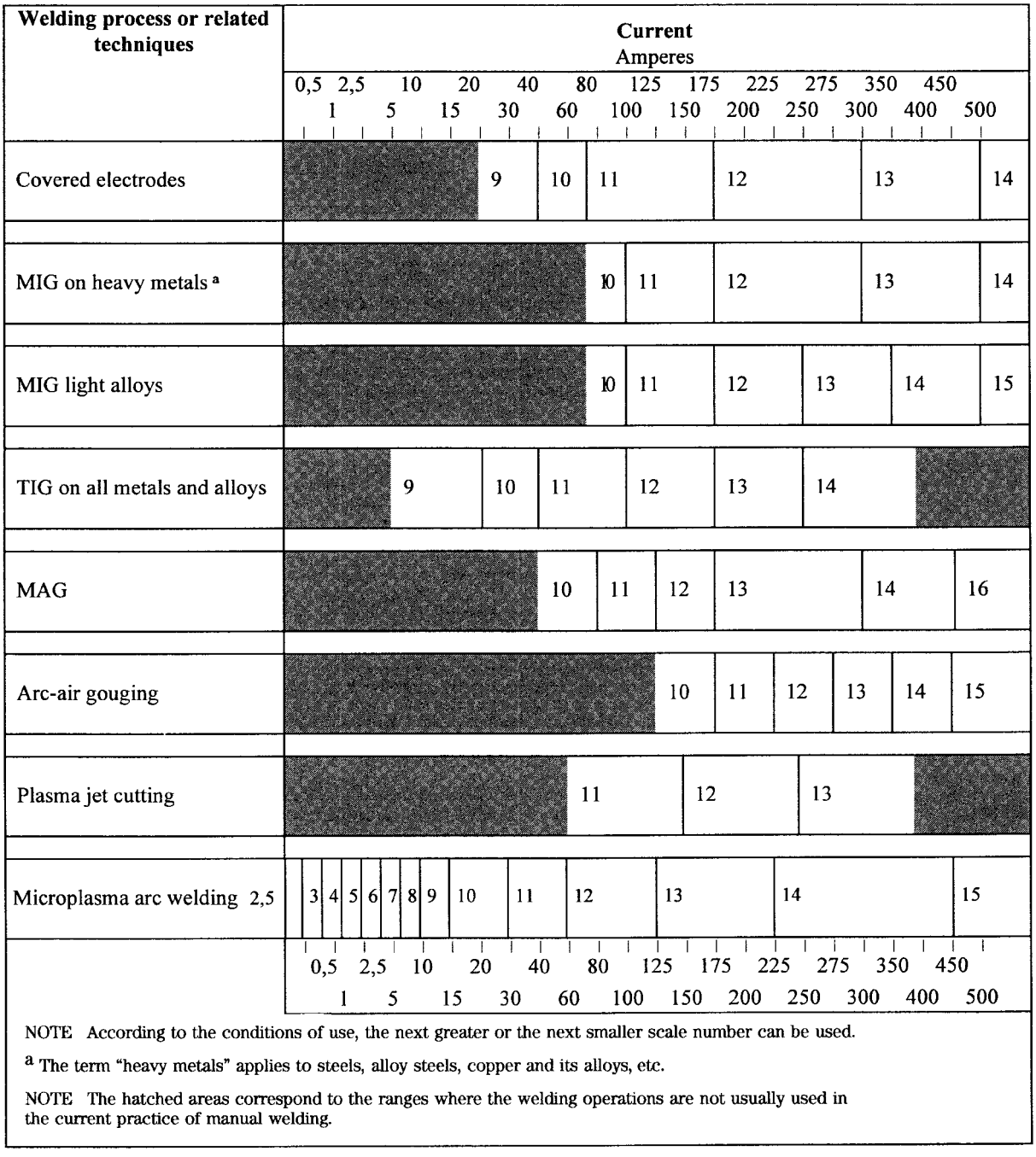
NOTE According to the conditions of use, the next greater or the next smaller scale number can be used.

[a] The term "heavy metals" applies to steels, alloy steels, copper and its alloys, etc.

Table 9 — Scale numbers to be used for oxygen cutting (see note)

Work	q = flow rate of oxygen, in litres per hour		
	$900 \leq q \leq 2\,000$	$2\,000 < q \leq 4\,000$	$4\,000 < q \leq 8\,000$
Oxygen cutting	5	6	7
NOTE According to the conditions of use, the next greater or the next smaller scale number can be used.			

Table 10 — Scale numbers to be used for electric arc welding (see note)



NOTE According to the conditions of use, the next greater or the next smaller scale number can be used.

[a] The term "heavy metals" applies to steels, alloy steels, copper and its alloys, etc.

NOTE The hatched areas correspond to the ranges where the welding operations are not usually used in the current practice of manual welding.

Dust particles (large and fine) and gas hazards also require the orbital cavities to be adequately protected and therefore only goggles are suitable.

Short circuit electric arc hazards require full face protection and therefore only face-shields are suitable.

Molten metal hazards are considered to be too severe to permit the use of spectacles and it is therefore necessary to specify goggles or face-shields. Goggles should only be selected if the risk assessment indicates that the molten metal hazard will not present a significant risk of facial injury.

Mesh type eye-protectors may be spectacles, goggles or face-shields and are used principally in forestry applications where abrasion from foliage could cause deterioration of the surface of clear oculars or in high radiant heat situations where a wire mesh provides greater protection to the eyes.

Wire mesh eye-protectors cannot be used against molten metal splash, short circuit electric arc, liquid splashes or droplets, coarse dusts, fine dusts or gases. They may be used against high speed particles but with the same limitations on styles for levels of impact energy as conventional general-use eye-protectors.

If UV, IR or sunglare radiation is deemed to be a hazard then suitable filtering oculars conforming to BS EN 170, BS EN 171 or BS EN 172 are necessary.

6.2.3.3 *Welding eye-protectors*

The choice of welding spectacles, goggle or shield will be governed largely by the required performance characteristics and conditions of use.

Spectacles and goggles do not provide protection to the face and therefore they are not suitable if face protection is also required against weld splatter and/or radiation from electric-arc welding which can burn exposed skin.

Welding spectacles do not completely enclose the orbital cavities and therefore do not offer protection from stray radiation. Spectacles are usually only specified for brazing and cutting operations and for those people not directly involved in the welding process or those visiting the welding area.

Welders' shields provide the fullest protection to the face and can also be fitted with capes and bibs to provide neck protection. Handshields are more convenient for certain operations than faceshields but offer less reliable protection as they rely on the operators judgement and expertize in positioning the shield adequately at all times.

Table 7 gives details of suitable styles if additional protection is required from high speed particles or molten metals

6.2.3.4 *Laser eye-protectors*

Laser eye-protectors are principally spectacles of special design that give a high degree of enclosure to the eyes. Goggle styles are also available, and faceshields.

Laser oculars can be particularly heavy and comfort can be compromised.

6.2.3.5 *Other selection considerations*

6.2.3.5.1 *General*

Such considerations as cost, availability, technical support, back-up service, etc. can all influence the final selection; other significant issues are addressed in the following sub-clauses.

6.2.3.5.2 *Corrective eye-protectors*

Persons requiring vision correction can wear face-shields and certain types of deep framed box goggles over their normal corrective spectacles. In addition, if a spectacle type eye-protector affords appropriate protection special corrective eye-protectors are available to cover all categories, including low energy impact, applicable to standard non-corrective safety spectacles.

If face-shields or goggles are worn by a person over their standard corrective spectacles then it is necessary to determine that any likely impact will not transmit to their non-safety oculars as these could fracture and cause serious injury.

6.2.3.5.3 *Comfort and fit*

It is essential to consider aspects of comfort and fit when selecting suitable eye-protectors. Wearers of uncomfortable products will be tempted to remove them, or not even wear them, in the hazardous environment. If adequate attention is not given to achieving a good fit then the eye-protector will not necessarily provide the intended level of protection.

To provide good comfort and fit, many types of spectacles are provided with adjustable sidearms and tilting frames. Some spectacles can also be fitted with pliable sidearms which can be shaped over their entire length for optimum comfort and fit.

Single size non-adjustable spectacles are in common use but these cannot be expected to provide satisfactory comfort and fit to all wearers.

The weight and balance of eye-protectors have a significant influence on comfort and fit, together with nose-bridge design and frame curvature.

Goggles have to enclose the orbital cavities and are generally heavier than spectacles and are generally considered as less comfortable. The width, position and extendibility of the head-band are important comfort features together with the face flange profile. Goggles are usually of one size and cannot guarantee a secure comfortable fit on all individuals. To overcome these problems some types of goggle are provided with a deformable foam flange seal.

Most goggle frames are manufactured from pliable plastic and thus it is possible to achieve a better fit by progressive tightening of the head-band; however, this should be avoided if comfort is compromised.

Face-shields are worn either with a browguard or safety helmet. In this case an adjustable head-band is provided. Adjustments can be made to both the peripheral and crown straps to optimize comfort and fit. Comfort pads are available on most harnesses.

6.2.3.5.4 *Compatibility*

It is quite common for eye-protectors to be worn with other types of PPE such as safety helmets, ear-muffs and respirators. In these circumstances an evaluation should be made to determine that one item of PPE does not affect the fit of the other, if it does then one or both items of PPE may not provide the intended degree of protection.

The most common causes of incompatibility problems are as follows:

a) sidearms of spectacles and head-bands of goggles disturbing the correct fit of ear-defenders;

b) the nose-bridge of spectacles and goggles disturbing the fit of half mask and filtering face-piece respirators, and vice-versa.

Problems of incompatibility sometimes require the preferred type and style of eye-protection to be substituted for another. Faceshields generally cause no problems of incompatibility when worn over filtering face-piece respirators. Safety-helmets fitted with a faceshield are available with integrally fitted ear-defenders; special shallow box-type goggles are available specifically for use with safety helmets. Manufacturer's advice on corrective spectacles for use with full face respirators should be sought. Manufacturers can also provide appropriate data on the use of eyewear with ear defenders.

Also available for consideration are purpose-designed combination products such as powered helmet respirators and supplied air visors which combine eye protection with respiratory and other forms of protection. If such products are selected to provide protection against hazards to the eye then they should conform to the relevant eye-protection standards (BS EN 166, BS EN 169, BS EN 379, etc.).

6.2.3.5.5 *Ocular materials*

There are many different types of ocular material available together with various coatings to provide additional properties.

Toughened and laminated mineral glass oculars provide optimum abrasion resistance but are significantly heavier than equivalent thickness plastic oculars and cannot provide protection against high speed particles.

7 Care and maintenance of occupational eye-protectors

7.1 General

Occupational eye-protectors are subjected to many harsh environments and also need to withstand regular cleaning. Consequently they are prone to damage and wear and any such degradation can affect their performance. It is important, therefore to constantly inspect eye-protectors and maintain them in a condition which ensures continuing conformance to original specification. This clause details a number of procedures to help provide the correct information to users.

NOTE It is necessary to supply all eye-protectors with user instructions compiled by the manufacturer. Such instruction should be rigorously adhered to and take precedence over any contrary recommendations contained in this section.

7.2 Use and handling

Information on the following should be given to all users of eye-protectors.

Eye-protectors should be used and handled with care. They should not be misused or allowed to become damaged, worn or contaminated with dirt, grease or other foreign matter. Eye-protectors should be replaced if they have been subjected to significant impact, molten metal splash, etc. even if there is no obvious visible damage.

Spectacles should never be placed on a workbench or surface with the oculars facing downwards. Stickers or labels should not be attached to eye-protectors, and users should not mark or scratch them with identifying marks.

When not in use eye-protectors should be stored in a protected manner (see **7.6**).

User instructions should be examined for any special procedures relating to use and handling.

7.3 Inspection

Eye-protectors should be inspected prior to every period of use to confirm that they will provide the specified level of protection. There should be documented procedures, supported by training programmes, to ensure that the inspection is properly conducted.

The inspection criteria are subjective, but if during inspection, any doubts are raised concerning the integrity of an eye-protector it should be immediately discarded and replaced. Inspection criteria contained in user instructions should be rigorously applied.

During inspection, particular attention should be paid to the following.

a) **Oculars**. Any significant scratches, abrasions, clouding or discoloration should result in the oculars being replaced. Check also for any looseness in the frame;

b) **Spectacle frames**. These should be undistorted and undamaged and capable of being adjusted to give optimum fit. Adjustable sidearms should remain easily adjustable and without undue slackness. Sidearms should open and close freely but without excessive slackness in the hinge mechanism. Sideshields, if fitted, should be secure and undamaged.

c) **Headbands**. All headbands should provide a secure optimum fit and be easily adjustable. Elastic headbands should retain adequate extensibility and be unfrayed. There should be no slippage in headband assemblies when they are tightened.

d) **Housings and frames**. Goggle frames should not be damaged or distorted. Any ventilators or ventilation openings should be unclogged and secure in the frame.

e) **Faceshields**. Welding shield windows should hold the filters securely, flip down holders should close without allowing entry of stray light. Mesh screens should not be torn or distorted. There should be no signs of scratching, abrasion, fine stress cracking or heat damage.

7.4 Cleaning

Eye-protectors should be cleaned, as necessary prior to storage, following the procedures contained in the user instructions. Generally, the eye-protector should be cleaned with a non-abrasive mild detergent, warm water and a soft lint-free cloth; followed by rinsing and drying.

Manufacturers' cleaning solutions may be used but any "general purpose" cleaning solution should be treated with suspicion. Solvents or industrial cleaners should not be used.

The employer should make facilities and materials readily available for the cleaning operation and should introduce the necessary procedures and controls to ensure it is undertaken effectively.

7.5 Repair and replacement of parts

No repairs should be undertaken to eye-protectors other than under the written authority of the manufacturer. Unauthorized repairs may compromise the specification, invalidate certification/approval and negate a manufacturer's warranty.

Replacement of parts should be conducted strictly in accordance with manufacturer's instructions which should identify those parts which may be replaced.

Any repair or replacement of parts should be carried out by a suitably trained person and clearly documented.

7.6 Storage

Procedures in user instructions on storage conditions should be rigorously adhered to.

Any necessary cleaning should be performed prior to storage.

Eye-protectors should be provided with individual storage facilities to protect from dirt, oil, grease, excessive temperatures, strong sunlight, strong artificial light, moisture and high voltage equipment.

It should be checked that the eye-protector is not distorted during storage. If pliable spectacle cases are provided these should not be placed in any pocket which will cause the spectacle to be compressed.

8 Occupational eye-care programmes

8.1 General

The selection, issue and maintenance of eye-protectors is a demanding procedure which requires specialist knowledge and careful attention to many issues. It is advisable that this procedure is conducted within a planned framework. This procedure, commonly known as an eye-care programme is usually broadened to address other related issues such as education, vision screening and administration procedures.

Eye-care programmes should be tailored to the needs of an organization, there is no universal format. The aim of this clause of the document is to provide suggested elements of an eye-care programme to assist organizations in adopting and implementing procedures suited to their particular circumstances.

8.2 Programme

8.2.1 *Legal and organizational requirements*

The first essential stage in developing an eye-care programme is to determine and understand the legislative and organizational framework within which the programme needs to operate. National regulations governing approval and certification of eye-protectors should be reviewed to identify the relevant standards and certification marks that are required to be present on any eye-protectors to be sourced. Duties of the employer and wearer in relation to selection and use should also be clearly understood.

Apart from legal aspects, the eye-care programme should also consider any organizational constraints in relation to working practices, trade union involvement, senior management commitment, budget requirements, etc.

8.2.2 *Survey and risk assessment*

The programme should include a detailed survey of the working environment and an assessment to identify the nature of the risk and the persons subjected to it. All practicable means should be used to eliminate hazards at source prior to considering personal eye-protection.

Details of the survey, risk assessment and resulting conclusions should be documented for future reference and review.

8.2.3 *Vision screening and administrative procedures*

Prior to embarking on the selection process, the individuals identified as requiring eye-protection should be subject to a vision screening process. This process will identify those persons who require vision correction and who subsequently, should be referred to an optician for a full eye examination.

Many eye-protector manufacturers and other specialist organizations offer a vision screening service. Larger organizations may also operate their own vision screening service or invite an optician to their premises to conduct the survey. Alternatively, an employer may decide to ask all those involved in the programme to visit their optician for an eye-test or eye-examination.

Results of the vision screening and any eye-examination exercise should be documented. It is good practice to repeat this process at least once every two years to accommodate changes in wearer vision. New personnel joining an organization should be included in the vision screening/eye-test programme at the earliest opportunity.

Administrative records of all aspects of the eye-care programme including details of the operation, the risk assessment, the persons working in the hazard area, vision screening results, legislative and organizational requirements, source and type of selected eye-protectors, cleaning and maintenance schedules, wearer experiences, optician involvement, education programmes, training, etc. should be kept.

8.2.4 ***Education and training***

It is important to gain acceptance of the eye-care programme from all members of an organization. Any lack of commitment could result in a slackening of procedures which in turn could result in serious consequences for those operating in the hazardous area.

The eye-protection wearers should be given instruction about legislative requirements, the nature of the hazard and the eye-protector selection process. Details should be given of the importance of vision and the delicacy of the human eye.

Involving the wearer in the selection process and explaining in detail why a particular eye-protector has been selected for their needs can help encourage its wear.

Training should be given in fitting the eye-protector and in its care, use and maintenance. The administration procedures should also be explained together with the requirement to report any malfunction, damage or excessive wear.

It should also be explained to first time wearers that a period of adjustment could be necessary to grow accustomed to the new protector. Minor headaches and diminished spatial awareness are common complaints from first time wearers but such symptoms usually resolve themselves within a few days of use. Emphasising the importance of eye-protection and the fact that no visual harm will result from wearing, it can help counter any initial misgivings.

8.2.5 ***Selection and wearer trials***

The eye-protection selection process commences once the details of the risk assessment have been analysed. The overall selection procedure is shown in Figure 3.

It is important to involve the wearers in the selection process by providing a range of suitable eye-protectors and conducting representative wearer trials. It is unlikely that any one style or model will suit all users, a selection should be made available.

The wearer trials should include assessments of comfort, fit, maintenance procedures, storage requirements, compatibility and any other factors that influence the long term acceptability of the product. Suitable questionnaires should be designed, completed and analysed to determine an overall acceptability rating.

The selection procedure should be documented together with details of the selected eye-protectors.

8.2.6 ***Issue and fitting***

The issuing of the selected eye-protectors to the wearers should be accompanied by a review of the correct fitting procedure and instructions for care and maintenance as detailed in the training programme.

Storage arrangements should be reviewed and any necessary documentation issued for recording historical details of the wearing experience.

Details of the issuing process, personnel details and records of the selected eye-protectors should be logged as part of the administration procedure.

8.2.7 ***Monitoring and review***

To check that the eye-protection programme is working effectively the experience of the wearers should be monitored in a systematic manner. Checks should be made that the eye-protectors are being worn in the prescribed manner and for the prescribed duration. Investigation should be made of any wearer problems or complaints. Checks should be made that inspection, cleaning, maintenance and storage procedures are being properly adhered to.

A checklist should be produced including all the above factors and filled in at regular intervals. The results should be reviewed and fed back into the eye-care programme so that it can be continually improved by the benefit of experience.

Audits should also be performed on the administration procedures to check they are being correctly completed and continue to effectively control the eye-care programme.

Regular reviews of the risk assessment should be conducted to identify any change to the nature or extent of the hazard. The selection procedure also requires regular reviews to accommodate changes in personal requirements and to consider any new eye-protectors that may become available.

8.2.8 ***Visitors requirements***

Arrangements should be made for providing visitors to any hazardous site areas with suitable eye-protectors. These should be segregated and separately identified from general issue, and be selected according to the risks encountered by the visitors.

If spectacles or goggles are appropriate style of eye-protector these should be of the type that can be worn over normal prescription spectacles.

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[1] Personal Protective Equipment at Work Regulations 1992 (SI 1992 No 2966, as amended by SI 1996 No 3039) London. The Stationery Office.
[2] Health and Safety at Work, etc. Act 1974 London. The Stationery Office.
[3] Control of Substances Hazardous to Health Regulations 1994 (SI 1994 No 3246) London. The Stationery Office.

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