

CONFIRMED
DECEMBER 2007

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

ICS 13.340.20

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee PH/2, Eye protection, to Subcommittee 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

This British Standard, having been prepared under the direction of the Health and Environment Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 November 1999

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Amendments issued since publication

Amd. No.	Date	Comments

The following BSI references relate to the work on this standard:
Committee reference PH/2/2
Draft for comment 98/541939

ISBN 0 580 33047 8

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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use and maintenance of occupational eye and face protectors*, which was itself partly based on BS 7028:1988 which is withdrawn.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 account 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 Health 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.

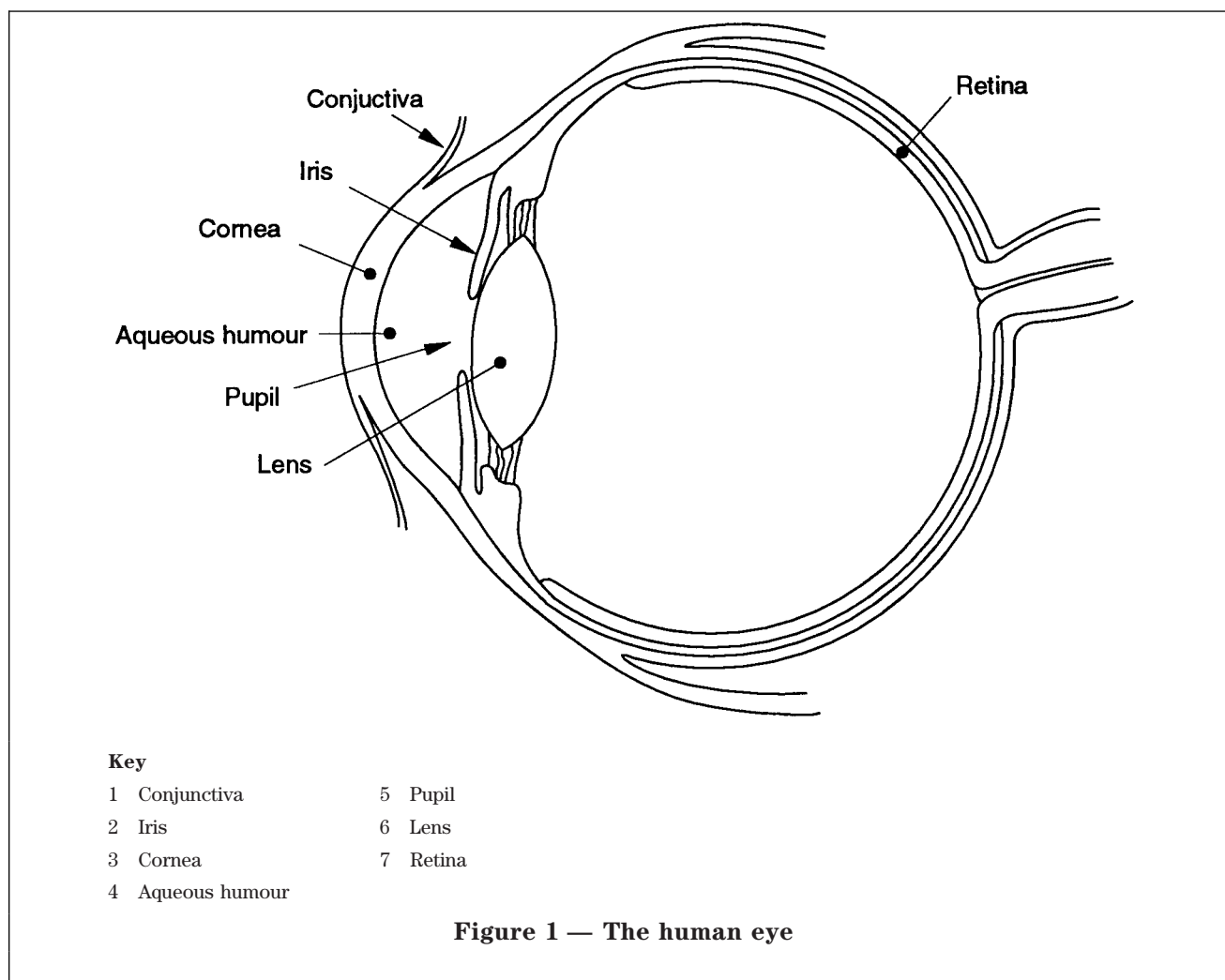
The damaging effects on the human eye that can arise from the various hazards are numerous and complex and range in severity from minor irritation to total blindness. To help explain these effects, discussed in the following clauses, a sectional diagram of the eye, highlighting the principal components,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



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	Gammas 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

