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Protective eyewear

A reference guide for ABDO members

New 2014 revised edition

Association of British Dispensing Opticians

Industrial prescription protective eyewear

Legal requirements

On 1st January 1993, in line with a European Directive, the Government of the UK introduced new legislation on Health and Safety at Work. These effectively replaced the old UK legislation of 10th April 1947.

Six areas were considered within the legislation, one of which was personal protective equipment (PPE). The regulations were published under the Health and Safety at Work Act 1974 as Personal Protective Equipment (European Community EC Directive) Regulations 1992 SI 1992/3139.

Eye protection was included in these regulations.

The 1993 regulations apply to all workers in the UK, with the exception for crews of sea-going ships (there is also some debate about the protection afforded to military personnel).

As a result of the publication of these rules all previous legislation was completely revoked. The regulations relating to eye protection are now taken as European Normals ie EN standards.

British, European and International standards are:

- BS EN 169:1992. Personal eye protection: Filters for welding and related techniques: Transmittance requirements and recommended use
- BS EN 172:1995. Specification for sunglare filters used in personal eye protectors for industrial use
- BS 7930-1:1998. Eye protectors for racket sports. Squash Oculars.
- BS EN 174:2001. Ski goggles for downhill skiing.
- BS EN 166:2002. Personal eye protection: Specifications
- BS EN 167:2002. Personal eye protection: Optical test methods
- BS EN 168:2002. Personal eye protection: Non optical test methods
- BS EN 170:2002. Personal eye protection: Ultraviolet filters: Transmittance requirements and recommended use
- BS EN 171:2002. Personal eye protection: Infrared filters: Transmittance requirements and recommended use
- BS EN 379:2003 + A1: 2009. Personal eye protection. Automatic welding filters. Welding filters with transmittance variable by time and zone
- BS EN 14458:2004. Personal eye-equipment. Faceshields and visors for use with firefighters' and high performance industrial safety helmets used by firefighters, ambulance and emergency services.
- BS EN 1731:2006. Personal eye protection. Mesh eye and face protectors
- BS EN ISO 4007:2012. Personal protective equipment - Eye and face protection - Vocabulary
- BS EN ISO 8980-3:2013 Ophthalmic optics - Uncut finished spectacle lenses Part 3: Transmittance specifications and test methods
- BS EN ISO 12312-1:2013 Eye and face protection - Sunglasses and related eyewear - Part 1: Sunglasses for general use
- BS EN ISO 12311-1:2013 Personal protective equipment - test methods for sunglasses and related eyewear

Types of protective eyewear

Spectacles, goggles and shields
As previously stated, all protective eyewear in the UK must conform to the European standard EN 166:2002, which has several differing levels of impact resistance, indicated by symbols.

The range of symbols used in lens type marking are:

Symbol	Property
S	Increased robustness (toughened glass and thickened CR39)
F	Low energy impact (polycarbonate and Trivex)
B	Medium energy impact
A	High energy impact
9	Non-adherence of molten metal and resistance to penetration of hot solids
K	Resistance to damage by fine particles
N	Non-fogging properties

Note: When medium energy impact resistance, denoted as EN 166 B, is required or, there is a requirement for protection against electrical arcs, welding materials and corrosive materials, prescription spectacles should not be supplied and goggles, or visors, should be considered, which must carry the appropriate EN specifications.
Grade B test: 6mm, 0.86g steel ball travelling at 120 metres per second

When high energy impact resistance (EN 166 A) is required visors or face shields must be supplied.
Grade A test: 6mm 0.86g steel ball travelling at 190 metres per second

Low energy impact grade (EN 166 F) is the highest level of impact offered by protective spectacles/glasses.
Grade F test: 6mm, 0.86g steel ball travelling at 45 metres per second (polycarbonate and Trivex)

CR39 (with increased thickness) and toughened glass (usually thermally toughened in the UK) are materials offering increased robustness (EN 166 S).
Grade S test: 22mm, 43g steel ball travelling at 5.1 metres per second. This is derived from the practical test which is to drop the ball (as stipulated) from a height of 1.3 metres.

Markings required on the lenses of supplied protective spectacles

N..... Manufacturer's mark
1..... Optical class
S or F ..... Impact grade

There will probably also be a Kitemark, which is not a regulatory requirement, but a manufacturer's stamp of quality.

The Kitemark: is considered the world's premier symbol of trust, integrity and quality. It indicates that manufacturers carrying the mark have satisfied the most rigorous quality process. The scheme is developed by using BS, EN, ISO or Trade Association specification.

Lenses

Marks: The manufacturer's mark, which is useful as the source is traceable in the event problems, (plus Kitemark), 1 - F or 1- S.

In a number of working environments it may well be possible to only provide appropriate over-goggles, or side shields, to spectacle wearers, but such steps should only be regarded as temporary measures. It should be noted that these measures are not suitable for prolonged or regular use.

Frames

These may be manufactured in metal (often nickel alloys - plated) and plastic (commonly cellulose acetate, polymamide or polycarbonate).

Functionality and use dictates their design, but a range of colours and styles are readily available from the appropriate suppliers.

Frames must also carry the appropriate markings, which are:

Marks: Manufacturer's mark, offering traceability (plus Kitemark, not a requirement).

EN 166..... Relevant standard.
F..... If the frame claims to meet low energy impact (no markings are required for Grade S increased robustness).
CE mark ..... Products must meet legal requirements before they can be sold within the European Community, and must carry CE marking. CE marking attached to a product is a manufacturer's claim that it meets all the requirements of European legislation.

Technical information

	BS EN 166		PROTECTOR TYPE		
	Frames	Lenses	Spectacles	Goggles	Faceshields
Manufacturer's mark	**R**	**R**	•	•	•
Optical class					
Refractive power +/-0.06	-	1	•	•	•
Refractive power +/-0.12	-	2	•	•	•
Refractive power +0.12	-	3	•	•	
Refractive power - 0.25	-	3	•	•	
Mechanical strength					
Increased robustness	-	S	•	•	•
Low energy impact	-F	F	•	•	•
Medium energy impact	-B	B		•	•
High energy impact	-A	A			•
Field of use					
Liquid droplets/Splashes	3	-		•	•
Large dust particles	4	-		•	
Gas/Fine dust particles	5	-		•	
Short circuit electric arc	8	-			•
Molten metal/Hot solids	9	9		•	•
Resistance to fogging	-	N	•	•	•
Resistance to surface damage (damage by fine particles)	-	K	•	•	•

Reference

Norville Group. *Protective Eyewear*. Catalogue dated February 2012 p11.

Standards for eye and face protection

General

BS EN 166:2002 - Personal eye protection - specifications
Not all types of eye protector are permitted to meet all these requirements.

The order of markings on **oculars**, where relevant, is:
- Scale number (filters only)
- Manufacturer's mark
- Optical class
- Mechanical strength
- Fields of use
- Scratch resistance
- Resistance to fogging
- Radiant heat

The order of markings on frames, where relevant, is:
- Manufacturer's mark
- EN166
- Fields of use
- Mechanical strength

Scale number - for oculars with filtering effect only. Higher numbers have a stronger filtering effect (eg are darker for welding). Scale number consists of a **code** number and a **shade** number separated by a hyphen, except for welding filters which have no code number. For example, an IR filter with shade number 4 has the scale number 4-4.

Welding filters - see BS EN 169 and BS EN 379
Shade number between **1.2** and **16.** Suffix **a** denotes filter for use in gas welding with flux.

UV filters - see BS EN 170
2- or **3-** minus code number denoting UV filter without or with good colour recognition respectively, plus shade number between **1.2** and **5**.

IR filters - see BS EN 171
4- minus code number for IR filters, plus shade number between **1.2** and **10**.

Sunglare - see BS EN 172
5- or **6-** minus code number for sunglare filters without or with IR specification respectively, plus: shade number between **1.1** and **4.1** and **BS EN 1836**.

Optical class
1, 2 or 3 - indicates optical quality of the ocular. Class 1 is the best.

Mechanical strength - marked on frames and/or oculars

Symbol	Property
S	Increased robustness Increased robustness (oculars only)
F	High speed particles, low energy impact (any type)
B	High speed particles, medium energy impact (goggles and faceshields only)
A	High speed particles, high energy impact (faceshields only)

Fields of use

Frames

Symbol	Property
3	Resistant to liquid droplets (goggles), or liquid splashes (faceshields, but not mesh)
4	Resistant to coarse dust particles
5	Resistant to gas and fine dust particles
9	Resistant to molten metals and hot solids
G	Resistant to radiant heat (BS EN 1731 faceshields only)

Oculars

Symbol	Property
8	Resistant to short circuit electric arc (faceshields only)
9	Resistant to molten metals and hot solids (goggles and faceshields only)

Other ocular markings

Symbol	Property
K	Resistant to surface damage by fine particles
N	Resistant to fogging
G	Resistant to radiant heat (BS EN 1731 faceshields only)

BS EN 1731:2006. Personal eye protection. Mesh eye and face protectors
Note: The requirements and markings for radiant heat, which appear in BS EN 1731:1998, have been deleted from this standard.

The order of markings (following EN166), where applicable, is:
- Manufacturer's mark
- BS EN 1731:2006
- Mechanical strength

Mechanical strength: **S, F, B or A** - as for BS EN 166

Fire fighters and emergency teams

BS EN 14458:2004 - Faceshields and visors for fire fighters, ambulance and emergency services

Symbol	Property
=	General (non-fire fighting) use
+	Fire fighters' use
⊙	Face guard, or eye guard

Options: Scale number appropriate to filtering performance (see EN 166)

Temperature extremes of testing

Symbol	Property
T	Resistance to medium energy impact at extremes of temperature
A	Resistance to high energy impact
AT	Resistance to high energy impact at extremes of temperature
K	Resistance to abrasion
N	Resistance to fogging
R	Enhanced infrared reflection
Ω	Electrical properties

Sport

BS EN 174:2001 - Ski goggles for downhill skiing
Filtering oculars marked according to transmittance:
S# - in range **S0** to **S4**. Higher number indicates lower transmittance

BS 7930-1:1998 - Eye protectors for racket sports - Squash Oculars
The order of other markings is:
- Manufacturer identification
- Standard number **(BS 7930-1)**

Frames
The order of other markings is:
- Manufacturer identification
- Standard number **(BS 7930-1)**
- Model size if applicable

Industrial prescription protective eyewear

Assessment of required protective eyewear

Health and Safety at Work Regulations require the employer to identify and evaluate workplace risk. This is commonly undertaken by the company safety officer. The reason for this is that in order to do a comprehensive assessment, someone with access to, and familiarity with, the working environment is essential. This effectively means that a practice-based optician is not the appropriate person to assess such risk, though they may well dispense the required protective eyewear.

The net result of this is that the patient will come into the practice with a 'Company' order form. This will stipulate the type of lens and lens material required.

Note: If this is not stipulated contact the company health and safety officer before proceeding. The frame may also be specified though, frequently, a choice is offered to the patient from a stipulated range.

On occasions, however, a self-employed tradesman may come into the practice requiring protective eyewear. In this instance the optician should perform a detailed assessment of the patient's requirements and the type of hazards that are associated with their day to day work. If it is feasible contact a local company involved in the same, or very similar, work type. Alternatively the optician should contact a supplier involved in the supply of protective eyewear to seek their advice. However when the optician proceeds, he/she should keep detailed case records of the reasons for their choice of lenses and frames supplied.

Once an order has been established the spectacles must be ordered from a recognised safety eyewear manufacturer. This will ensure that the necessary standards are met and that a proper certificate is issued at the time of completion.

The norm when 'Company' safety spectacles are being supplied is that the optician will receive a fee for the dispensing service. There are no specific amounts established for the dispensing service so this should be agreed with the supplier before proceeding.

Care of protective eyewear

Not all responsibility lies with the employer. The wearer has obligations to wear the protective eyewear when required and in the manner that they were issued for. The wearer, or another party, must not interfere with, abuse, or alter the appliance in any way.

Advice on the proper care of the appliance should be given (how to clean and the benefits of putting into the case provided when not in use). **Never use acetone or methyl chloride to clean polycarbonate.**

Avoid extreme heat (unless specifically designed for such use) and humidity.

It is very important that the optician is aware of the very limited actions that they can perform with regard to protective eyewear; effectively this is limited to adjustment only. The optician must never undertake any repair - even replacing a screw. Such action would invalidate the protection guarantee. All repairs must be returned to the original supplier who will, when completed, issue a new guarantee certificate.

Sunglass protection

Sunglass tints will reduce light transmission, but should offer protection from hazardous radiation, depending on the tasks and environment for which they will be worn.

Ultra-violet (UV)
Almost all solar UV radiation is absorbed firstly by the earth's ozone layer and then by the anterior structures of the eye. A very small amount reaches the retina. UV absorption by the eye may contribute to age-related and other changes in the ocular tissue and a number of serious eye conditions.

UV is classified according to wavelength:

- UVA(315 nm – 380nm) - possible cataract formation, skin cancer and/or retinal damage with long term exposure.
- UVB (280nm – 315nm) can damage the cornea, the conjunctiva and the crystalline lens. 'Snow-blindness' is extreme photo-keratitis caused by UVB.
- UVC (100nm - 280nm) is absorbed by the ozone layer.

Infra-red (IR)
Opinions are divided on the damage caused by IR to ocular tissue, even under very bright solar illumination. IR protection is essential in industrial environments when IR radiation exposure is extreme.

Blue light (380nm - 500nm)
Sometimes referred to as high-energy visible light (HEV), some sources claim evidence for damage to ocular tissue by blue light.

The standards which refer to the blue light hazard state that there is little short-term risk associated with exposure to blue light, but that the long-term risk could be greater.

There are two important standards that should be consulted for information related to dispensing spectacles for sun protection:

1) BS EN ISO 8980-3:2013 Ophthalmic optics - Uncut finished spectacle lenses Part 3: Transmittance specifications and test methods

2) BS EN ISO 12312-1:2013 Eye and face protection - Sunglasses and related eyewear - Part 1: Sunglasses for general use

Although only BS EN ISO 8980-3 relates specifically to prescription lenses, BS EN ISO 12312 contains specifications which should be applied to all sunglasses.

New in the standards is the minimum specification for lens size in order to adequately protect the eye;

Filter category	Description	Range of luminous transmittance from over	to
0	Clear or very light tint	80%	100%
1	Light tint	43%	80%
2	Medium tint	18%	43%
3	Dark tint	8%	18%
4	Very dark tint *(not suitable for driving or road use in any conditions)*	3%	8%

40 □ 28 for adults and 34 □ 24 specified for children. Also specified is the requirement for temporal shielding for category 4 tints so that the light transmittance around the sunlens is not greater than that at the visual point.

Note: BS EN ISO 8980-3 states that *'Spectacle lenses with a luminous transmittance less than 75% shall not be used for road use and driving in twilight or at night.'*

This specification overlaps somewhat with the filter categories, but nevertheless is the most up-to-date directive.

There are additional requirements for driving sunlenses regarding traffic signal detection, so it should be ensured by discussion with the manufacturer that the tint dispensed complies. The best advice should be for no tinting to the lens, but an MAR coat should be a must (perhaps a gold reflex, an arguable aid to contrast). For users working long hours under fluorescent lighting, a blue reflex may be helpful to counter the tiny amount of UV emitted from this type of lighting.

- Driving and road use - Filters suitable for daylight are: **0, 1, 2** and **3**
- Filters from **1 - 4** are not suitable for night driving and road use
- Filter category **4** not suitable for driving or road use per se

Although the above filter categories refer to plano sunglasses the information is also very relevant to prescription sunglass wear.

Other specialist sun protection lenses

Polycarbonate
Where safety or wrap around types are required polycarbonate is commonly used (polycarbonate, in white form, eliminates 100% of UV @ 380nm).

Polarised lenses
Which are the only truly anti-glare lenses, should be recommend for use on and around water (fishing, sailing, water skiing etc). For prolonged wear, there is a very valid argument for the addition of a mirror coating, to counteract the increased UV being reflected from the water. It is also a very good driving/road use tint, especially in wet conditions on a bright/sunny day. Consideration should also be given to 'DriveWear' lenses (for daytime use only), which combine photochromic technology with polarisation.

Sunglass protection

Continued

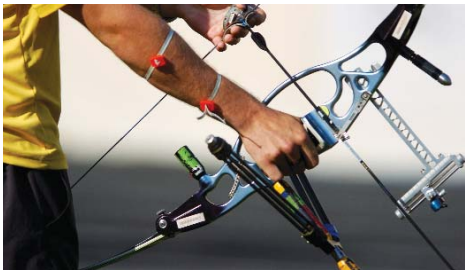
Snow Skiing

Eye protection for skiing is usually used in goggle form and, where a prescription is required, inserts may be fitted.

Snow reflects visible and UV light, increasing the overall brightness. In sunny conditions very dark brown tints can be dispensed.

BS EN ISO 12312 states '*…in extremely high luminance conditions, such as desert and snowfields under full sunlight, the use of category 4 filters may be recommended.*'

For overcast, flat light days, in which there is an over-abundance of blue light, yellow or rose tints may be used. Grey tints reduce transmittance across the spectrum. Polarised lenses may also be used, but these tend to mask small contours on the slope. Visible and UV transmittance may also be further reduced by the use of mirror coatings.



Shooting / archery

A bronze tint should be used for skeet, clay-pigeon and trap shooting. It is also the tint of choice for hunting.

For black on white target shooting yellow tints offer good contrast. However, targets may vary in colour. For orange targets use an orange tint. Red and pink tints are good for black and green targets and are also effective on orange targets and for hunting; they also reduce the effects of a green background, grass, trees and shrubs. A red tint can improve colour differentiation for people with a colour vision problem.

Tints should not be too dark, as this results in an enlarged pupil, which can adversely affect the shooters'/archers' performance. Compare this to the pinhole effect, which sharpens the image.

Cricket
Tints will vary according to the light conditions, but the purpose is mainly to enhance contrast. The spectacles are mostly wrap around and will benefit from a mirror coating (cricketers spend prolonged periods in the field increasing UV exposure).

Tropical/desert use
According to BS EN ISO Standards, IR radiation on the ground, even under extreme illuminance conditions, poses no risk to the ocular tissues. Prolonged exposure in desert environments may, however, pose some risk according to some scientists. Protection from infrared is achieved by the use of ferrous oxide in the glass lens mix, eg Rayban G15. However, as the G15 is a solid glass tint differing thicknesses in the lens will result in an uneven tint. This can be addressed with bonded/equitint forms.

Photochromic lenses
Photochromic lenses should be recommended for patients who are generally light sensitive, who like a flexibility in their tint, or for pathological/ genetic conditions, such as albinism.

Sports and home protection

DIY
The DIY amateur is just as vulnerable to accident as the professional, arguably more so. He/she should be encouraged to have the necessary eye protection. Hazards may include flying particles, dust, chemical compounds (ammonia, acids, super glue). Is it surprising that there are more accidents in the home than at work? The emmetrope should wear wrap around goggles (injection moulded polycarbonate). The spectacle wearer should at least have some form of over protection.

Hard ball and racket sports
For 'hard' ball and racket sports impact resistance is the prime concern.
Hard resin CR39 may be used, but polycarbonate or Trivex are preferable.

Squash
Squash is particularly hazardous, as the squash ball is almost equal in size to the eye's orbit, therefore orbittal fractures are a common injury. **All** squash players should have eye protection. There are specifically designed goggles for squash use which must be fitted with the most efficient impact resistant lenses.

Swimming goggles
Poor vision and the salt or chlorine in water can make swimming an uncomfortable experience. Plano swimming goggles are available, as are ready-wear prescription goggles, incorporating basic spherical lens powers, or goggles with the patient's accurate prescription incorporated. Impact resistance is a consideration, though CR39 material should be adequate.

Diving (scuba and snorkeling)
The protection of the ocular area is a very important factor, hence normally a face mask is supplied (a firm water-tight fit is essential). Plano masks are available; for prescription use masks with inserts may be used or the prescription lens may be stuck/cemented to the rear surface of the mask with accurate centration.

Cycling
Cycling has many facets to consider when supplying the protective unit, which are most commonly supplied in goggle form because this offers good all round protection. These are obtainable in plano form and as goggles which are fitted with prescription inserts or as prescription lens goggles using freeform technology. The tint choice is an important factor from the light transmission to UV protection to contrast requirements. Protection from wind, dust and impact are also essential. Vitally important is a firm and stable fit.

Football
Attention should be drawn to the ABDO *'Children's eye protection in football'* publication, a guide for referees, coaches and parents. This is available upon application and is free to ABDO members.

These are just some of the types of specialised eyewear encountered in practice. However, with responsibility comes liability, so always keep detailed practice records, even when supplying non-prescription units.

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As standards are subject to regular updates and changes, please note the information in this brochure is only accurate at the time of going to press.

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