Eye Protection

Guidance for University Departments and Functions

June 2002

Safety Services Office
Departmental eye protection procedures

Heads of Departments or their nominees are responsible for:

- Identifying eye injury hazards arising from work in their areas
- Assessing the risk, and
- Ensuring that the most suitable precautions are taken to minimise the risk of eye injury.

There have been a number of incidents of chemical splashes to the eye in recent years, sometimes involving laboratory staff and sometimes domestic staff in student accommodation. These accidents occur in departments in which eye protection is not mandatory; in the Department of Chemistry, where all students and staff working in laboratories are required to wear eye protection, no eye splash accidents have been reported within the same period of time. This highlights the need to remind managers, supervisors and staff of the necessity not only to provide eye protection but also to ensure its use.

Prevention of eye injury deserves special attention; the eye is particularly vulnerable to physical and chemical damage, and such damage is often permanent, leading to irreversible effects on eyesight.

In each Department it is necessary to identify eye injury hazards arising from work undertaken in the area, assess the risk, and ensure that the most suitable precautions are taken to minimise the risk of eye injury.

There is a common misconception that, if a supply of protective clothing and equipment is made available, then the employer’s duty is discharged and it is up to the employee to use it – any injury due to non-use then being the employee’s own fault. This is certainly not the case. When a risk assessment indicates that eye protection is needed, it becomes mandatory to provide it, and to ensure that it is used (The Personal Protective Equipment (PPE) at Work Regulations 1992, Regulations 4, 6 and 10.)

Eye injury hazards

Hazards include:

- Machining of metal, wood and plastic.
- Grinding and chipping with power operated tools.
- The use of hand tools, chisels and wire brushes for certain operations.
- The handling of molten metal.
- The use of compressed air "blow guns".
- Handling and use of caustic, corrosive or irritant chemicals.
- Work in laboratories containing experiments involving chemicals that are liable to react violently.
- Pushing liquids and solutions through syringe filters.
- Pumping liquids and solutions under pressure.
- Pressure systems and vacuum systems.
- Cryogenics, e.g. liquid nitrogen.
- Exposure to certain types of non-ionising radiations (e.g. UV, lasers.)
- Using “strimmers” and hedge trimmers.

Having identified the hazards, the normal risk assessment process should be used and control measures identified. It is a requirement of the Management of Health & Safety at Work
Regulations 1999 and the Personal Protective Equipment (PPE) at Work Regulations 1992 that personal protective equipment, such as eye protection, should be used as a last resort. It should only be used as a control measure when there is a residual risk after other measures have been applied, i.e. elimination of the hazard, substitution with a lesser hazard, engineering controls and procedural controls (see the section “Eye protection as PPE”, page 4.)

**Eye protection areas**

Where a risk assessment indicates that an individual needs eye protection when carrying out a certain operation or process, but that other people working in or visiting the area are not at risk, eye protection needs only to be provided to that individual. If the risk assessment indicates that other people are at risk, the area should be designated an EYE PROTECTION AREA. In Eye Protection Areas, all personnel must wear at all times the eye protection provided or required. Appropriate safety signs must be posted at the entrance to those areas and a stock of eye protectors must be kept by the member of staff in charge of the area for issue to students and visitors. The Safety Services Office can advise on suitable signs.

**Types of eye protection**

Depending on the risk, it may be necessary to provide:

- Safety spectacles or eyeshields
  - For most situations, safety glasses with side shields are adequate.
- Safety goggles
  - Where there is danger of splashing chemicals that could damage the eye, the use of safety spectacles with side shields is advisable, but goggles may be necessary if indicated by the risk assessment.
- Face shields
  - For more hazardous operations such as conducting reactions which have potential for explosion, or using or mixing strong acids or alkalis, a face shield or a combination of face shield and safety goggles or glasses should be used.

See Appendix 2 for further details of eye protection types.

Operations such as washing glassware in chromic acid, grinding, and laboratory operations using glassware where there is risk of explosion or breakage (e.g. at high or low pressure or temperature), will generally need goggles or face-shields.

For special situations such as, electric arc welding, use of UV lamps and transilluminators in laboratories, and use of lasers, appropriate specialist eye protection should be selected with advice from the equipment supplier. There are British and European Standards on eye protection for welders (see References.)

The Safety Services Office will be pleased to advise on the choice of eye protection.

**Students, visitors and contractors**

Students must follow exactly the same eye protection rules as employees. Visitors must also be required to follow the same eye protection rules as employees whilst on University premises. If they do not provide their own eye protection, it is the Department’s responsibility to provide adequate protection where required. It is the responsibility of the
employee hosting the visit to enforce the rules. After use, safety glasses or goggles used by
visitors should be cleaned prior to re-use.
Contractors working on University premises are expected to provide their own personal
protective equipment (refer to the University document “Contractors: General code of safe
practice”.) However, the University owes a common-law duty of care towards any persons
working on the premises, as well as a statutory duty under the Health & Safety at Work etc.
Act 1974. If contractors are judged to be at risk of eye injury from the University’s activities
and do not have their own eye protection, it would be prudent to provide it, as for visitors.

**Special cases**
All staff and students at the University who have monocular vision or other eye defects and
who work in laboratories or other work areas where there is an inherent risk of damage to the
eyes must wear safety spectacles at all times whilst in those areas.
Wearers of contact lenses should seek advice from their optician on the advisability of
wearing the contact lenses in eye protection areas, especially those involved in the use and
handling of hazardous chemicals. Contact lens wearers are advised to inform their supervisor,
line manager, Laboratory Safety Supervisor or demonstrator, as appropriate, that they are
wearing contact lenses, so that First Aiders can be informed in the event of a splash to the eye
requiring the eye to be washed out.

**First aid and eyewash facilities**
Eyewash facilities must be readily available, in the form of either an eye wash fountain or
plenty of eyewash bottles (sterile water or saline.) If the latter are used, the use-by date should
be checked regularly and the solution replaced when necessary.
In the event of a chemical splash, flushing of the eye must commence immediately and a First
Aider should be summoned. The eye should be held open. The liquid should be allowed to
drain to the side of the face to minimise the risk of contaminated washings entering the other
eye.
Helpers must not try to remove any foreign body from the eye.
In the event of a splash with corrosive liquid, the eye should be flushed for at least 15 minutes
(or as advised by current First Aid training if this differs.) Following First Aid treatment the
casualty must be sent to hospital.
An Accident Report Form should be filled in and sent to Safety Services.

**Provision of eye protection**
Protective clothing and equipment must be provided at no cost to the employee, and where
practicable it should be provided on a personal basis. If possible, employees should be
allowed to choose their own. A newly-appointed staff member working in a laboratory, for
example, could be allowed to choose from a range of frames in a laboratory supplies
catalogue. This could be made part of the Departmental safety induction. When eye protection
is needed for occasional use only, a communal supply can be kept. For example, safety
spectacles for visitors to a laboratory can be kept in a dispenser outside the laboratory.
Departments should consider providing prescription safety eyewear to wearers of prescription
spectacles who need eye protection for most or all of their daily work. There is no legal
obligation to do so, but few over-spectacles are available that are of good enough quality for
all-day use. Over-spectacles can be perfectly adequate for occasional use and for visitors. The
Safety Services Office will be pleased to advise. Prescription lenses are available in glass,
CR39 and polycarbonate. With regard to mechanical strength, glass and CR39 only meet the
general-purpose “S” level of impact protection (see Appendix 1.) Polycarbonate meets the
“F” level (low-energy impact.) CR39 shatters when tested to the “F” level.
Safety eyewear chosen should be approved to the European Standard EN166 (which superseded BS 2092.) Details of product marking under this Standard are in Appendix 1.

Safety spectacles provided by the University are safety equipment supplied in pursuance of the Health & Safety at Work etc. Act 1974 and must not be deliberately altered or damaged in any way (HSWA 1974 Section 8). Any such action is an offence by the employee under the Act.

Fit and comfort

It is now possible to find safety eyewear in different sizes. Some styles are adjustable, with temple length adjustment, tiltable front lens or both. Many accidents involving foreign bodies in the eye are a direct result of a product not offering sufficient protection around the eye area. If eye protection is close fitting on the brow and cheek area, it is obvious that greater eye protection is going to be achieved. With goggles, the fit is important, as no contaminant should be able to penetrate the goggle around the area in contact with the face.

Comfort during prolonged wear is improved if the product is of good optical quality, i.e. non-distorting. Products with EN 166 marking have an Optical Class (1-3) indicating refractive tolerance, Class 1 being the best. Class 1 products are recommended if all-day wear is necessary.

Ensuring use

Once the Department has agreed what the rules will be, compliance is best achieved by “top-down” demonstration of commitment, by the willingness by all staff who are in a supervisory position to enforce the rules, and by active encouragement of all staff to follow the rules. A Head of Department or supervisor who never wears safety spectacles in the laboratory, but tells others that they must, has little chance of achieving compliance. Newcomers are likely to comply if they see that their peers do.

Periodic monitoring, and reminders to staff who are not wearing their eye protection, are likely to be needed. The Departmental Safety Inspection is a good opportunity to monitor and report on whether eye protection is being worn when it should be.

With perseverance, the wearing of eye protection becomes the norm and something people do without a second thought, rather than something unusual that people do reluctantly. The reasons that people are being required to wear eye protection should always be stressed – eye injuries can be devastating. Even the most minor eye splash is uncomfortable, and the first aid treatment (having one’s eye forced open and copiously irrigated) is not pleasant. It can also be embarrassing to the casualty, inevitably interrupts their work and wastes their time.

Eye protection as PPE

Eye protection is a class of Personal Protective Equipment (PPE.) The information given here is supplementary to that in the University of Leicester document “Personal Protective Equipment”. 1

The Personal Protective Equipment (PPE) at Work Regulations 1992 require that:

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1 In preparation
“Every employer shall ensure that suitable personal protective equipment is provided to his employees who may be exposed to a risk to their health or safety while at work except where and to the extent that such risk has been adequately controlled by other means which are equally or more effective.”

PPE is always the “last resort” in a hierarchy of control measures, i.e. engineering controls and safe systems of work should always be considered first. It may be possible to do the job by another method which does not require the use of PPE. In some circumstances PPE such as eye protection will still be required to control the risk adequately, and the PPE at Work Regulations will then take effect.

Briefly, the provisions of the PPE Regulations are:

**Provision of PPE**
Suitable and sufficient PPE must be provided where there are risks to employees’ health and safety that cannot be adequately controlled by other means. The Approved Code of Practice to the Regulations clearly sets out what is meant by suitable; e.g. the PPE selected must give adequate control of the risk and must be of adequate quality.

**Compatibility of PPE**
If more than one item of PPE is needed, the equipment must be compatible and continue to control the risks when worn together. For example, goggles must still fit properly if a safety helmet has to be worn at the same time.

**Assessment of PPE**
PPE must be chosen that is correct for the hazards involved in a task and the circumstances of use.

**Maintenance and replacement of PPE**
PPE must be issued to the wearer clean and in good working order. There must be arrangements for its replacement, repair and cleaning as necessary.

**Accommodation for PPE**
PPE must be safely stored when not in use, to protect it from contamination, loss or damage.

**Information, instruction and training**
Workers must be trained and informed so that they can make effective use of their PPE.

**Use of PPE**
Employers must ensure that PPE provided is used as instructed. Supervision should be provided to ensure that the training and instructions are being followed.

**Reporting loss or defect**
Employers must have arrangements to make sure that employees can report loss or defects, and arrangements for repairing or replacing defective PPE before the employee starts work again. Employees must report loss or defects as soon as possible.
Appendix 1 - Types of eye injury and causes

The following statistics were obtained from a study in the United States of 1,000 eye injuries:

- About 70% of eye injuries are caused by flying or falling objects or sparks striking the eye. The majority of these are small particles travelling at high speed.
- 20% of injuries are caused by contact with chemicals.
- About 60% of workers injured were not wearing any eye protection at the time. Of those who were wearing eye protection, most were wearing protective spectacles with no side shields.
- 94% of the injuries to workers wearing eye protection resulted from objects or chemicals going around or under the protector.
- Breakage of the eye protection occurred in only 13 out of the 1,000 cases.
- Workers injured while not wearing eye protection most often said they had believed it was not required by the situation.
- The vast majority of employers had provided eye protection, but about 40% of the injured workers had received no information on when and what eye protection should be used.
- Over 50% of those injured while wearing eye protection thought that the eyewear had minimised their injuries.
- Nearly 50% of the workers felt that another type of protection would have better prevented or reduced their injuries.

Examples reported at the University of Leicester:

Catering areas:
- Oven gel splashed into eye whilst cleaning grill
- Foreign body entered eye whilst cleaning cooker top

Laboratories:
- Solution heated in a microwave spurted on to face and eyes
- Solution spurted into eye from a syringe
- Microbial culture splashed into eye
- Solution of a toxic substance spilt on face and arms.

Examples reported at other universities/colleges:

A research student melted polyvinyl alcohol gel in a microwave oven. On removal from the oven the hot liquid splashed in the student's eye. Eye protection was not being worn.

A research assistant was capping plastic vials of "scintillation cocktail", when some splashed into her right eye, causing temporary stinging. Eye protection was available but was not worn.

A technician was trying to correct a fault in disinfectant handling apparatus. Some disinfectant splashed into the eye, causing blistering of the inner eyelid of one eye.

Plastering - failed to use goggles - foreign body in eye
Welding - struck in eye by flying debris
General cleaning - nozzle came off spray bottle - fell to floor and splashed contents
Electrician stripping cable - debris in eyes (3 cases, two to the same person - tradesman not student)
 Splashed thinners in eye - no eye protection was being worn.
Appendix 2 – British and European standards

The introduction of the European Standard EN166, which superseded the BS2092 standard and came into full effect in the late nineties, meant that additional tests were required for a manufacturer to acquire the eyewear certificate for its product. The requirements of the standard and the corresponding markings are set out in the table below.

<table>
<thead>
<tr>
<th>BS 2092 and EN 166 Markings</th>
<th>BS 2092 marking (frame and lens)</th>
<th>EN 166 marking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Optical Class:</strong> *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refractive Tolerance ± 0.06dio.</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Refractive Tolerance ± 0.12dio.</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Refractive Tolerance ± 0.12-0.25dio.</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td><strong>Mechanical Strength:</strong></td>
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<td></td>
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<tr>
<td>Minimum robustness</td>
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<tr>
<td>Increased robustness (General Purpose – 12m/s)</td>
<td>BS 2092</td>
<td>-S</td>
</tr>
<tr>
<td>Low-energy impact (Grade 2 – 45m/s)</td>
<td>BS 2092:2</td>
<td>-F</td>
</tr>
<tr>
<td>Medium energy impact (Grade 1 – 120m/s)</td>
<td>BS 2092:1</td>
<td>-B</td>
</tr>
<tr>
<td>High energy impact (190m/s)**</td>
<td>-</td>
<td>-A</td>
</tr>
<tr>
<td><strong>Field of Use:</strong></td>
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</tr>
<tr>
<td>Basic</td>
<td></td>
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<tr>
<td>Liquids (Chemical)</td>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>Large dust particles</td>
<td>D</td>
<td>4</td>
</tr>
<tr>
<td>Gas and fine dust particles</td>
<td>G</td>
<td>5</td>
</tr>
<tr>
<td>Short circuit electric arc</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Molten metals and hot solids</td>
<td>M</td>
<td>9, 9</td>
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<tr>
<td><strong>Optional requirements:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance to misting</td>
<td>-</td>
<td>-N</td>
</tr>
<tr>
<td>Resistance to surface damage (hard coat)</td>
<td>-</td>
<td>-K</td>
</tr>
</tbody>
</table>

* For all-day wear, optically correct lenses (products of optical class 1) are recommended.
** Applies only to face shields.

New eye protection will be CE marked (category 2 or 3.) Older items may have the British Standard kite mark.
Products will also have a manufacturer’s mark.

Other special Standards exist for certain specific risks, e.g. BS 1542 specifies equipment for eye, face and neck protection against radiation arising during welding operations.
Appendix 3 - Extract from “Personal Protective Equipment at Work” (HSE)

(Personal Protective Equipment at Work Regulations 1992 - Guidance on Regulations, L25)

Eye protection

Types of eye protection

83 Eye protection serves to guard against the hazards of impact, splashes from chemicals or molten metal, liquid droplets (chemical mists and sprays), dust, gases, welding arcs, non-ionising radiation and the light from lasers. Eye protectors include safety spectacles, eyeshields, goggles, welding filters, face-shields and hoods. Safety spectacles can be fitted with prescription lenses if required. Some types of eye protection can be worn over ordinary spectacles if necessary.

Processes and activities

84 The following are examples of activities and processes involving a risk to the face and eyes for which eye protectors should be used. It is not an exhaustive list.
(a) handling or coming into contact with acids, alkalis and corrosive or irritant substances;
(b) working with power-driven tools where chippings are likely to fly or abrasive materials be propelled;
(c) working with molten metal or other molten substances;
(d) during any welding operations where intense light or other optical radiation is emitted at levels liable to cause risk of injury;
(e) working on any process using instruments that produce light amplification or radiation; and
(f) using any gas or vapour under pressure.
Eye protectors must be provided both for persons directly involved in the work and also for others not directly involved or employed but who may come into contact with the process and be at risk from the hazards.

85 Some relevant British and European Standards:
BS 6967:1988 GLOSSARY OF TERMS FOR PERSONAL EYE PROTECTION (To be replaced by BS EN 165)
BS 2092:1987 SPECIFICATION FOR EYE PROTECTORS FOR INDUSTRIAL AND NON-INDUSTRIAL USES (To be replaced by BS EN 166, 167 and 168)
BS 7028:1988 GUIDE FOR SELECTION, USE AND MAINTENANCE OF EYE-PROTECTION FOR INDUSTRIAL AND OTHER USES
BS 1542:1982 SPECIFICATION FOR EQUIPMENT FOR EYE, FACE AND NECK PROTECTION AGAINST NON-IONISING RADIATION ARISING DURING WELDING AND SIMILAR OPERATIONS
NOTE: Many British Standards will be replaced by harmonised European Standards, for example BS 3864:1989 will be replaced by the European Standard EN 443. When the European Standard is introduced it will be prefixed by 'BS' so EN 443 will become BS EN 443 in the United Kingdom. Those with the prefix 'pr' are provisional at the time of going to print. See Appendix 3 for a more comprehensive list of appropriate standards.

Selecting suitable eye protection

86 The selection of eye protection depends primarily on the hazard. However, comfort, style and durability should also be considered.
(a) SAFETY SPECTACLES are similar in appearance to prescription spectacles but may incorporate optional sideshields to give lateral protection to the eyes. To protect against impact, the lenses are made from tough optical quality plastic such as polycarbonate. Safety spectacles are generally light in weight and are available in several styles with either plastic or metal frames. Most manufacturers offer a range of prescription safety spectacles which are individually matched to the wearer.
(b) EYESHIELDS are like safety spectacles but are heavier and designed with a frameless one-piece moulded lens. Vision correction is not possible as the lenses cannot be interchanged. Some eyeshields may be worn over prescription spectacles.
(c) SAFETY GOGGLES are heavier and less convenient to use than spectacles or eyeshields. They are made with a flexible plastic frame and one-piece lens and have an elastic headband. They afford the eyes total protection from all angles as the whole periphery of the goggle is in contact with the face. Goggles may have toughened glass lenses or have wide vision plastic lenses. The lenses are usually replaceable. Safety goggles are more prone to misting than spectacles. Double glazed goggles or those treated with an anti-mist coating may be more effective where misting is a problem. Where strenuous work is done in hot conditions, 'direct ventilation' goggles may be more suitable. However these are unsuitable for protection against chemicals, gases and dust. 'Indirect ventilation' goggles are not perforated, but are fitted with baffled ventilators to prevent liquids and dust from entering. Indirect ventilation goggles will not protect against gas or vapour.

(d) FACESHIELDS are heavier and bulkier than other types of eye protector but are comfortable if fitted with an adjustable head harness. Faceshields protect the face but do not fully enclose the eyes and therefore do not protect against dusts, mist or gases. Visors on browguards or helmets are replaceable. They may be worn over standard prescription spectacles and are generally not prone to misting. Face shields with reflective metal screens permit good visibility while effectively deflecting heat and are useful in blast and open-hearth furnaces and other work involving radiant heat.

Maintenance

87 The lenses of eye protector must be kept clean as dirty lenses restrict vision, which can cause eye fatigue and lead to accidents. There are two methods for cleaning eye protectors. Glass, polycarbonate and other plastic lenses can be cleaned by thoroughly wetting both sides of the lenses and drying them with a wet strength absorbent paper. Anti-static and anti-fog lens cleaning fluids may be used, daily if necessary, if static or misting is a problem. Alternatively lenses can be 'dry' cleaned by removing grit with a brush and using a silicone treated non-woven cloth. However plastic or polycarbonate lenses should not be 'dry' cleaned as the cloth used in this method can scratch them.

88 Eye protectors should be issued on a personal basis and used only by the person they are issued to. If eye protectors are re-issued they should be thoroughly cleaned and disinfected. Eye protectors should be protected by being placed in suitable cases when not in use. Eye protector headbands should be replaced when worn out or damaged.

89 Lenses that are scratched or pitted must be replaced as they may impair vision and their resistance to impact may be impaired. Transparent face shields must be replaced when warped, scratched or have become brittle with age.
Appendix 4 - ACCIDENT AT 2 AM!

By Professor K. Barry Sharpless

Many of you may know that I was blinded in one eye during a lab accident in 1970, shortly after I arrived at MIT as an assistant professor. I always wore glasses whenever I was at my bench, and while I felt I conscientiously observed safety measures, my experience proves one can't be too cautious about wearing safety glasses.

As I prepared to go home from the lab during the early hours of the morning of the accident, I looked in the bays to see what my co-workers were doing, and then returned to my own bench, removed my safety glasses, and put on my parka. As I was walking to the door, I passed the bench where a first-year graduate student was flame-sealing an NMR tube. I asked how it was going, and he replied, "Good. I've got it sealed".

He was sealing off the tube at atmospheric pressure under a flow of nitrogen gas while cooling the tube in a liquid nitrogen bath, a technique neither of us had performed before. Nor, I regret to say, had we looked up the procedure, which we subsequently discovered to be incorrect.

I stopped by his bench, picked up the tube from the bath, and held it to the light. The tube immediately frosted over, and, as I wiped it to better see the contents, I noticed that the solvent level was exceedingly high. Suddenly the solvent level dropped several inches. Though I instantly realized condensed oxygen had been sealed in the NMR tube, I was quite literally unable to move a muscle before it exploded. Glass fragments shredded my cornea, penetrated the iris, and caused the partial collapse of one eye. My only other injuries were superficial facial cuts.

My first two weeks at Mass Eye & Ear were spent totally immobilized and with both eyes bandaged. The pain was terrific, but my fear was even greater: I had been warned that when my eyes were uncovered there was a small chance I might be blind in both eyes due to "sympathetic ophthalmia". Because eyes are walled off from the rest of the body in utero, eye protein driven into the blood stream can raise an immune response that leads to the "killing" of an uninjured eye. My disappointment at having no functional vision in my injured eye was, needless to say, surpassed by my joy at retaining full vision in my good eye.

The lesson to be learned from my experience is straightforward: there's simply never an adequate excuse for not wearing safety glasses in the laboratory at all times.

(Massachusetts Institute of Technology Department of Chemistry)
References


3. British and European Standards:
   a. BS EN 166 Personal eye-protection – specifications
   b. BS EN169 Specification for filters for personal eye-protection equipment used in welding and similar operations
   c. BS EN 379 Specification for welding filters with switchable luminous transmittance and welding filters with dual luminous transmittance
   d. BS EN 175 Personal protection - Equipment for eye and face protection during welding and allied processes
   e. BS 1542 Equipment for eye, face and neck protection against non-ionizing radiation arising during welding and similar operations