Topic 5: EYE PROTECTION AND OTHER PERSONAL PROTECTIVE EQUIPMENT

This Topic replaces Topic 5 in the third edition of Topics in Safety. Many of the changes are minor except for significantly more detail on the use of face masks at the end of the Topic, section 5.5.6.

5.1 Introduction

The *Personal Protective Equipment at Work Regulations* (1992)[1] require employers to provide their employees with the personal protective equipment (PPE), which is deemed necessary as a result of an appropriate risk assessment. The general duty of care for others (ie students and visitors) in the *Health and Safety at Work Act* means that the employer must also look after the safety of others using the premises. This means that where PPE is deemed necessary in science teaching, it must be provided and correctly worn by staff, students and others. Although the duty rests with the employer, in practice the provision of PPE in science is delegated to the head of science, and the requirement to ensure it is correctly worn is delegated to individual science teachers in their lessons.

The form of PPE most commonly used in science teaching is eye protection. Most laboratories are equipped with a class set of safety goggles or spectacles and prep rooms are likely to need one or more face shields. It is now well established that eye protection is routinely worn in science lessons because of the risks to the eyes from handling hazardous chemicals, heating liquids and some solids, grinding solids, some dissection work, etc. Evidence suggests that despite this, eye incidents are still quite common. They occur when:

- students remove their own eye protection at the end of their practical whilst others around are still working
- students fail to wear eye protection correctly
- teachers (or students), believing a substance to be low hazard (e.g. limewater), do not ensure eye protection is worn
- spilled crystals and liquids are inadvertently rubbed into an eye on fingers contaminated from the bench
- occasionally one student deliberately squirts a hazardous liquid at another

The only other PPE which might be considered necessary in science lessons are gloves, aprons, lab coats and some means of tying back long hair. It is possible to envisage a situation where wellington boots might be needed (see section 5.5). It must be remembered that PPE should not be the first line of defence. Any activity should be queried in which the risk assessment identifies that some significant item of PPE (other than the usual) is required. Are there safer alternative procedures? Can the quantity or concentration be reduced? Will a fume cupboard or safety screen reduce the risk? Can students simply be kept out of the way? Is the activity educationally valid?

The two questions with regard to PPE are:

- what kind of PPE should be worn?
- when should PPE be worn?

These are considered separately, first for eye protection and then for other forms of PPE.

[1] HSE (1992) L25 *Personal Protective Equipment at Work. Guidance on Regulations: Personal Protective Equipment at Work Regulations* 1992. HSE Books. ISBN 0 71760415 2.

5.2 Teachers are responsible for students wearing PPE

If the risk assessment for an activity deems that PPE (usually eye protection) is needed, the class teacher is responsible for ensuring that it is worn. Many published texts now include eye protection symbols or words printed near to activities requiring its use. Departments are encouraged to use a similar approach with their own worksheets or workbooks. Including guidance on PPE is very helpful and acts as a regular reminder to students. However, it is not sufficient to rely on students noticing the warnings and wearing their eye protection. The teacher has to instruct the students that the eye protection is needed and to remind them during the lesson on several occasions if the eye protection is not being worn appropriately. Transgressions should not be ignored. It is also important that the teacher sets a good example by wearing his or her own eye protection and insisting that any others in the room (eg technicians or inspectors) do the same. Some departments display the blue and white circular eye protection safety sign (see Topic 9). Strictly speaking this is a mandatory sign and means eye protection must always be worn by anyone in the room, which is clearly not the case in all science lessons. In addition, such permanent signs quickly cease to have any impact. If a department wishes to make use of this safety sign then it is best used temporarily, for example, by sticking the sign to a magnetic board.

Following the above procedure will not guarantee that all students will always wear their eye protection correctly, but nothing will. However, it would indicate that the teacher had taken reasonable and appropriate steps to ensure students wear eye protection, or indeed any other kind of PPE.

5.3 Eye protection: what kind should be worn?

5.3.1 General points

Science departments tend to make eye protection last as long as possible, often well beyond its effective and useful life. Students are notoriously careless in the way they handle and put down their eye protection, so that lenses can quickly become scratched, ear pieces of safety spectacles can become broken and vents are removed from goggles so that they are no longer liquid-proof. It is necessary, therefore, for a science department to ensure that part of the annual budget is set aside for routine replacement. It is sometimes possible to purchase lenses separately so that scratched lenses can be replaced. However, replacing a lens is not necessarily easy and may actually invalidate the manufacturer's guarantee of security. In the main it is probably simpler and easier all round to buy new than to repair, although it is quite simple to replace the elastic straps of safety goggles.

Despite the general infrequency of cleaning, there is no evidence that infectious organisms can be transferred from one person to another through sharing eye protection. We are assured that viable head lice cannot be transmitted by headwear. However, since cleaning is easy (any washing-up liquid will do) it would seem sensible to aim to wash eye protection termly to ensure lenses remain clean and to enable staff to check its condition and the need for replacement.

5.3.2 European standards for eye protection

The European Standard, EN166, has been adopted as the British Standard, BSEN 166. This standard defines protection levels for the frames and, separately, for the lenses (oculars). The manufacturer is required to mould or stamp the codes for the protective standards onto the frame and lens. Where the frame and lens are part of the same moulding, often the case for safety spectacles, the combined markings will be found on the frame.

Markings on the **frame** are as follows:

- The first mark is the manufacturer's symbol
- The second is 'EN166'. All newly-purchased eye protection used in schools must be marked with this
- The third is one or more numbers to represent the correct application for the eye protection (see table 5.1). Safety spectacles, which offer basic protection, carry no number
- The fourth is a letter sometimes preceded by -, which denotes the resistance to the impact of high-speed particles (see table 5.1). If this letter is followed by a 'T', it denotes resistance to the same particles but at high temperature. This is not likely to be relevant in school science.
- Finally there will be a certification CE mark. Additionally there may be another certification mark (eg the kitemark), which is optional and can be used only when the eye protection has been independently tested and its properties confirmed. The British Standards Institute is one such independent testing organisation and it awards the kitemark.
- There may be additional markings,(as in the photograph) which the manufacture has chosen to add. However, there is no standard for this, the provision is for the benefit of the manufacturer possibly to distinguish between different versions of the eye protection.

Older eye protection, which is often found in schools, may carry the previous British Standard BS2092. Look for BS2092 for basic protection and BS2092C for protection against splashes of liquid.

Markings on the **lens** (ocular) are more complex than for the frames because they can include standards for optical quality and protection as well as impact resistance. They may also include manufacturer's product markings which have nothing to do with safety. However, for use in school science the lens markings should include, in order:

- The manufacturers mark
- The optical class, 1, 2 or 3, where 1 is the best.
- Mechanical strength, using the same codes as for frames
- Other markings which denote a range of features not generally relevant to school science such as resistance to short circuit electrical arc, surface damage by fine particles, etc.

Typical markings on the frame of eye protection

Table 5.1 Eye protection European Standard codes

Symbol	Explanation
None	Basic protection against low-level hazards (e.g. harmful/irritant substances) and general mechanical hazards.
3	Protects against liquid droplets and/or splashes
4	Protects against dust particles i.e. >5 µm
5	Protects against toxic and corrosive gases, vapours, sprays, smoke and dusts < 5 µm
8	Protects against short-circuit in electrical equipment
9	Protects against splashes of molten metals and penetration of hot solids
S	Increased robustness; can be applied to all types of eye protection.
F	Low-energy impact: can be applied to all types of eye protection. This level of protections is adequate for virtually all activities carried out by students in laboratories
B	Medium-energy impact; apples to goggles or face shield only
A	High-energy impact: applies only to specialized face shields

5.3.3 Acceptable kinds of eye protection

There are three kinds of eye protection acceptable for use in school science.

- **Spectacles**, which should conform to the basic standard. They are often the easiest to wear but they do not offer full protection against splashes. Many examples now have wide side pieces for sideways protection and fit close to the face to reduce the possibility of splashes entering the eye.
- **Goggles**, which should offer full protection against liquid splashes and basic protection for other hazards. Safety goggles must not be confused with other goggles such as those used in workshops which do not generally give splash protection and skiing goggles, which are generally unlikely to offer even the basic levels of protection required.
- **Face shields,** which are designed to protect the whole face.

Teachers and technicians should have a personal set of eye protection which they find comfortable and which accommodates any need for prescription spectacles. It is relatively easy to purchase prescription safety spectacles with impact-resistant lenses. As well, there ought to be one or more face shields available in the prep room for teachers or technicians to use.

Table 5.2 (overleaf) lists advantages and disadvantages of each type of eye protection.

Table 5.2 Advantages and disadvantages of different kinds of eye protection

	Advantages	Disadvantages
Spectacles	Comfortable Little restriction of vision (when clean and not scratched) Easy to wash Easiest to store Students wear them more readily	Only offer partial protection Do not generally fit over prescription spectacles Frames do not always protect the lenses from becoming scratched when spectacles are removed and put on the bench
Goggles	Offer greater protection than spectacles Often large enough to fit over prescription spectacles Rim protects lenses from scratching to some extent Elastic straps adjustable for different-size heads	Some models very uncomfortable More restricted vision than spectacles Tend to mist up Not always readily worn by students Surplus elastic sometimes a nuisance, and occasionally a fire hazard Slightly more expensive than spectacles
Face shields	Maximum protection for face and head Very wide angle of vision Will fit easily over prescription spectacles Visor can be replaced separately	Careful adjustment needed for secure fit Speech muffled and hearing may be slightly impaired Relatively expensive Some tendency to mist up Visor can, in some models, be flipped up which can be a minor hazard Very awkward to store

(Adapted from CLEAPSS guide R135 (March 2005) on eye and face protection.)

5.4 When should eye protection be worn?

5.4.1 When are the eyes at risk?

Clearly, eye protection should be worn whenever there is any foreseeable risk to the eyes, no matter what the practical work. A student's (and teacher's) eyes can be at risk:

- during teacher demonstrations
- during student practical work
- when the student has finished his/her practical work but neighbours are still doing it
- during clearing away and washing up.

Consideration should always be given to reducing risk to the eyes by changing the method of working. There is considerable scope for this in much practical work: e.g. heating liquids such as Benedict's reagent in a water bath; putting a **loose** ceramic wool plug in test-tubes before heating solids; keeping students at a safe distance during demonstrations. Safety screens, which protect more than the eyes, should be used whenever there is a risk of explosion, splashing or, as with alkali metals and water, where the reaction is well known to be vigorous and can lead to materials spitting. Technicians would be wise to wear eye protection when clearing away apparatus containing reagents or their reaction products which are known to be hazardous or are unknown.

5.4.2 What eye protection is needed for particular jobs?

It is difficult to give precise guidelines as to which type of eye protection should be used in particular circumstances. However, it is important for a science department to have a consistent policy based on an assessment of the circumstances of the school and department. The HSE has agreed that in school science:

- spectacles are suitable for most operations
- a set of goggles is available and worn where there is a particular risk
- a face shield is worn when large quantities of chemicals are dispensed, or cleared up after a spill.

This advice is a sensible compromise. We have found that the balance of advantage and disadvantage in many lessons falls in favour of spectacles because students wear these correctly most readily. However, where the danger presented by hazardous liquids (by their nature, concentration or temperature) is significant then goggles must be worn. Employers sometimes insist that only goggles are acceptable in science, but this is not the case and may actually be less safe. Students often find goggles less comfortable to wear and are tempted to remove them as soon as possible, irrespective of whether those around are still carrying out practical work.

5.4.3 Need for detailed local rules

Teachers and technicians must follow any rules laid down by their employer. However, choice of which type of eye protection to wear may be left to departments or individual teachers exercising their professional judgement. The following rough guide may help.

A Goggles are needed when handling:

- corrosive solids or liquids, including alkali solutions ≥ 0.5 M and most acid solutions ≥ 0.5 M
- toxic chemicals and solutions
- cryogenic liquids

B Spectacles: except for substances classified in A, spectacles are adequate for:

- heating chemicals (including instances where the heat comes from the reaction itself)
- shaking liquids in a separating funnel
- grinding solids with a pestle and mortar (but not oxidising agents)
- dispensing small volumes of liquids
- dispensing solids
- heating partially-sealed vessels (e.g. in gas preparations, passing gases over solids etc)
- handling
  - most organic liquids not covered in A
  - solutions of oxidising agents
  - dilute acids and alkalis (less than 0.5 M)
- glass working
- breaking rocks during geological studies
- stretching metal wires or plastic cords
- cutting and drilling resistant materials in the prep room
- dissection of material containing cartilage or bone
- any other operation likely to give rise to flying splinters

C Face shields should be worn when:

- dispensing large volumes of concentrated acids, alkalis (including ammonia) or other corrosive

substances

- opening and dispensing from storage containers that may be under pressure (e.g. '880' ammonia, hydrogen peroxide, silicon tetrachloride, etc)
- where the disability of a student with special needs requires her/him to work unusually close to hazardous chemicals or equipment

D Examples of when eye protection is not needed:

- using class 2 lasers (see Topic 18)
- using ultraviolet radiation – instead arrange the equipment so that the uv radiation cannot reach the eyes
- handling chemicals presenting no significant hazards

5.4.4 Other eye protection issues

a) Misting up

Misting up is a problem of both the outside and inside of lenses, mainly of goggles. Anti-mist sprays can be used and some goggles can be purchased with anti-mist properties. The tendency to mist up is one reason why students find goggles less easy to wear. Ventilated goggles are intended to allow moisture out but often fail. They have ventilation holes, which are covered by splash-proof caps. Note that some workshop goggles are vented directly, i.e. they simply have holes in. These do not give adequate splash protection and are therefore little better than safety spectacles.

b) Contact lenses

Contact lenses can be a problem in the event of an eye accident because they can be difficult to remove. Concerns that they impose a greater risk to the eyes in the event of an accident by hindering the washing out of chemicals have proved unfounded by research. Staff and students who wear contact lenses should wear eye protection of the same sort as the rest of the class.

c) Prescription spectacles

These will not offer any recognised level of protection. Neither staff nor students should be allowed to avoid wearing proper eye protection because they wear prescription spectacles. The department should ensure that an adequate supply of eye protection which fits over prescription spectacles is always available.

d) Pupils with disabilities

When pupils, such as those with poor eyesight, need to work very close to practical equipment, or when pupils have to sit during practical work (eg wheelchair users) involving hazardous chemicals or operations, they should wear goggles as a minimum, or a face shield as appropriate.

e) Eye washing

The simplest and most practical form of eye wash is a short length of rubber tubing attached to a suitable tap. The advantage of this is the availability of copious clean water for extended eye washing. Departments should place the length of tubing in a clear plastic bag pinned up very close to the tap designated for eye irrigation and labelled 'Eye-Wash Station' or similar.

Filled eye-wash bottles are less suitable because they contain only a small volume of water and, therefore, cannot provide sufficient capacity, especially if more than one student is affected or if prolonged irrigation is needed. They are also relatively expensive and difficult to keep in-date. Once opened, they should be replaced, and the department will require a management system which ensures this happens.

In the event that alkali splashes into the eye, continuous irrigation is required. An ambulance should be called and the crew told that the contaminant is alkali and advised to continue irrigation during the journey to hospital. Do not be tempted to stop irrigation after 10 minutes to take the affected individual to hospital.

Plumbed-in eye-wash stations are often too expensive for school use except if planned for in new buildings.

Emergency eye washing requires a degree of care to ensure that the eye of the injured individual is kept open and that the eyeball is rinsed as well as possible. Proficiency can be achieved through a short staff training session. There may even be a case for giving students, especially those in post-16 courses, similar training.

5.5 What other kinds of PPE should be worn, and when?

5.5.1 Gloves

Teachers and especially technicians should have access to appropriate gloves. There are times when heat-resistant gloves are necessary but a single pair in the department will usually suffice. Rubber or synthetic gloves may be needed (including, occasionally, by post-16 students) to prevent certain chemicals being absorbed by the skin. Kitchen gloves are often satisfactory for this purpose but are not impervious to all solvents and must be removed quickly if they come into contact with concentrated acids or other corrosives[2]. Kitchen gloves may be needed for clearing up after class practicals involving microorganisms or harmful liquids, when the risks are increased because of the quantity of materials or sets of equipment.

Gloves are rarely needed by pre-16 students but if the risk assessment identifies the need to wear gloves, they must be worn. Disposable plastic gloves are quite common in schools and are needed to protect the skin against contamination from radioactive substances. Some departments use such gloves when students are collecting litter or handling plant or animal material. In general, ensuring students wash their hands thoroughly with soap and water after such activities is a simpler and less-costly course of action. Cuts and scratches should be covered with waterproof plasters prior to the activity and sometimes wearing gloves may be helpful provided the teacher can ensure the insides of the gloves do not become contaminated. Many students, if offered a choice, will wear disposable gloves in order to stay clean or to avoid touching something thought of as distasteful. This is of course acceptable but is not a safety measure and the gloves cannot in such circumstances be regarded as PPE. The use of disposable gloves in the lab may increase hazards because it is more likely that, for example, a beaker of liquid may be dropped, especially if the gloves are wet.

5.5.2 Laboratory coats

The general purpose of lab coats is to stop an individual's clothes from getting dirty rather than serving as PPE. When properly buttoned up they can stop ties or other garments from hanging loose and getting into Bunsen-burner flames or becoming entangled with machinery. Lab coats constitute proper PPE in activities involving radioactive materials or microbiology, where removal of the lab coat removes possible contamination, and when handling large volumes of hazardous materials.

Teachers and technicians often wear lab coats and post-16 students are frequently encouraged to do so. This makes sound sense where any individual handles chemicals and other material frequently. However, the lab coat is only effective if it is properly buttoned up and teachers and technicians should set a good example in this. Some schools encourage younger students (ages 11–16) to purchase their own lab coat or wear some other old clothing over their normal wear. This helps prevent damage to clothes and as such can be a good idea. It is unlikely that a department could provide lab coats in sufficient quantity and range of sizes for all such students. Lab coats need regular laundering and a department must consider their safe storage when not in use.

[2] Further information on gloves for use at post-16 can be found in the Background Information section of the SSERC *Hazardous Chemicals Database* (**http://www.sserc.org.uk/index.php/chemistry-health-a-safety138/background-info208/protective-equipment/gloves**); and in section 20.12 of the CLEAPSS *Laboratory Handbook*

5.5.3 Aprons

Aprons will be required when dispensing large quantities of corrosive liquids and for pupils who remain seated when doing practical work. In such circumstances the apron should be large and made of an impervious material.

5.5.4 Protective headgear

This is unlikely to be needed except on some outside visits. Staff and students with long hair will need some arrangement to tie or clip it back, well out of the way of a Bunsen-burner flame or machinery.

5.5.5 Protective footwear

It is not normally necessary to provide or use protective footwear in school science. However, neither staff nor students should wear open-toed sandals when there is a risk of a spill of hot water or other liquid, or where there is the chance of breaking glassware. Ordinary shoes will allow chemicals through so must be removed quickly in the event of them becoming contaminated.

Along with the spill kit in the prep room, it is a good idea to keep a pair of wellington boots large enough for all staff to wear. In the very rare likelihood of a large container (e.g. 2.5 litres) of corrosive liquid being spilled, wellingtons will keep the feet well protected when dealing with the spill and cleaning up.

5.5.6 Face masks

The term face mask refers to a device used for respiratory protection, rather than a face shield, which is designed to prevent impact from solid particles or liquid splash on the face, especially the eyes. Face masks are also often called dust masks although many such masks will also filter out drops of liquid and vapour.

There is no requirement in normal science teaching, class practical work or lesson preparation for the use of a face mask. Control measures such as the use of a fume cupboard, or other forms of containment, mean that the use of a face mask is unnecessary.

The formal collective term for protective equipment which includes face masks is Respiratory Protective Equipment, which is inevitably often written as RPE. There is a plethora of types of respiratory protective devices. The only ones which have a role in a science department are those, relatively simple, disposable devices which protect against the inhalation of dusts and other fine particles. These are identifiable by the marking FFP1, FFP2 or FFP3. FF is short for *filtering facepiece* and P for *particle.* The numbers refer to the filtering capacity and the higher the number the greater the filtering, although it also becomes harder to breathe through (see Table 5.3 for further detail).

In a science department, a face mask is required for clearing up some fine powder spills and for cleaning out some animal housing. A face mask may also be a good idea when cleaning out a chemical store, or any room which has a significant build-up of spore-releasing mould on surfaces. It follows that several disposable face masks should be available as part of the department's emergency spills kit. Because it is not easy to identify what level of respiratory protection is needed in difference circumstances, the advice to a department is to only use masks to the standard FFP3, which offer the maximum protection. Thus, when dealing with an emergency, there is no need to delay over a decision on which to use.

Choose appropriate models of mask so that for all potential users, it will fit closely at all points in order to work effectively. Facial hair and spectacles may make it difficult to achieve a suitably close fit; therefore choose a type of mask which is designed to deal with these issues. (Note, some employees may have medical conditions, such as asthma or skin allergies, which prevent them from wearing a face mask.)

Using a face mask:

- Make certain all staff know how to put on, and remove, the chosen mask properly. Carefully follow the instructions given with the mask. Staff should practice putting on and wearing the mask to appreciate how it should feel when it fits correctly and how it affects breathing, misting of spectacles, etc. Training of this sort will mean some masks will have to be discarded afterwards, but

this is unavoidable. When removing a face mask after use, it is important that the mask is the last item of protective equipment to be taken off to avoid breathing in dust during the removal of contaminated clothing.

- Face masks of the sort recommended here should not be used continuously for more than 1 hour, after which they should be disposed of. Even if their use is for less than an hour these masks should be disposed of at the end of the day. Individuals should never attempt to share a face mask, but can reuse a single mask within the same working day, up to the 1 hour time limit.
- Do not buy face masks that are not marked EN 149, and FFP1, 2 or 3 from DIY stores or other outlets. Such masks have been described as nuisance dust masks with the suggestion that they are of use in dusty situations. The HSE, however, warns against the use of such masks in the workplace, since they meet no standard and therefore offer little, if any, real protection.

Table 5.3 Categories of face mask

All marked to the standard BS EN 149	Level of protection offered	Will filter:
FFP1	Protection level 4, which means the mask will notionally only allow through around a quarter of the particles in the breathable air. Under test conditions these masks work rather better than this and filter around 80% of particles.	Coarse dusts or fine neutral particles; eg as generated in craft activities.
FFP2	Protection level 10, which means the mask will notionally only allow through around a tenth of the particles in the breathable air. Under test conditions these masks filter out around 94% of particles.	Mildly toxic fine dusts, glass fibres, lead dust and fumes, asbestos.
FFP3	Protection level 20, which means that the mask will notionally allow through a twentieth of the particles in the breathable air. Under test conditions these masks filter out around 99% of particles.	Fine particles including those that are carcinogenic, spores, bacteria, enzymes and radioactive substances.

You will need to use a face mask when:

- clearing up spills of radioactive powders or radioactive materials which may have fragmented on being dropped or spilled
- cleaning up after a dry-powder fire extinguisher has been discharged (although this is often best left to professionals)
- clearing up significant spills of any fine powder such as carbon
- cleaning a cage used to house locusts or birds
- clearing out or cleaning a dusty chemical store room where there are visible deposits from leaking bottles
- clearing out or cleaning a store room which is or has been sufficiently damp to allow the growth of mould
- sanding benches.