Topic 8: Fire Precautions

This *Topic* (dated April 2012) is an updated version of *Topic 8* which appeared in the 3rd edition of *Topics in Safety* (ASE, 2001). Part of the updating involves the inclusion of additional examples of fire-related incidents.

8.1 Introduction

Major fires are not a frequent occurrence in school laboratories. Small fires resulting from laboratory accidents have been reported from time to time. Some of these are quoted as examples in this *Topic*, indented and in italics. Note that some go back many years, but they do serve to illustrate how unexpected some of the causes of fires can be. Fortunately, only a very small number of these had serious consequences for the students or adults involved.

The aim of this *Topic* is to help maintain the low incidence of accidents involving laboratory fires by considering some of the causes of fire and the best means of avoiding them. Whatever is recommended here, teachers and technicians must follow the rules or codes of practice laid down by their employers.

8.2 Risk Assessments

Legislation has changed in recent years, although as far as school science departments are concerned, the net effect has made little difference.

The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) 2002 cover flammable, explosive and oxidising substances. Amongst other things, they require employers to identify areas where explosive atmospheres might arise, carry out a risk assessment relating to the storage, transport and use of these chemicals and to mitigate the possible effects of fire and explosion.

The Regulatory Reform (Fire Safety) Order 2005[1] requires the responsible person (usually the headteacher or governors and, for community schools, with support from the local authority) to carry out a fire risk assessment to determine the control measures that are necessary in order to reduce the risk to employees and others from fire.

Whilst the fire risk assessment will be largely concerned with such matters as fire-exit routes, reducing the spread of fire by building design, emergency lighting and fire-extinguisher provision, senior managers in a school may perceive science departments as areas of particular risk. Whether or not this is a reasonable assumption is questionable but the information in this *Topic* should help inform any risk assessment.

8.3 Precautions

The aims of fire precautions are to:

- minimize the risk of a fire starting;
- avoid injury to people including fire-fighters;
- minimize the damage to property in the event of a fire.

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[1] In Scotland and Northern Ireland the equivalent legislation is The *Fire (Scotland) Act* 2005 and the associated *Fire Safety (Scotland) Regulations* 2006, and *The Fire and Rescue Services (Northern Ireland) Order* 2006 and the associated *The Fire Safety Regulations (Northern Ireland)* 2010.

There may be conflicts between the requirements of security and those of fire safety. For example, if the only emergency exit from a laboratory is through a preparation or store room, a fire risk assessment may conclude that the appropriate control measures include fitting the communicating door with panic bolts or not locking it at all, though the needs of security might suggest a mortise lock.

Fire alarms fitted with smoke sensors should not be used in laboratories, as they are likely to be triggered by many routine activities. Heat sensors are generally satisfactory but it is advisable to avoid activities (usually demonstrations) generating a great deal of heat directly underneath the sensor. Smoke sensors can be fitted in the ceiling of a stairwell but sometimes smoke drifting from a laboratory has triggered even alarms in the corridor.

Fire doors (smoke check doors) should be fitted with automatic-closing devices and not wedged or otherwise held open **except** when pushing a trolley, carrying bottles in a bottle carrier or carrying a tray. It is possible to install battery-operated devices containing a sound sensor to individual doors. These hold the door open until the fire alarm sounds, whereupon the door closes automatically. It is also possible to have a central system which keeps all the doors open until the fire alarm sounds, at which point they all close automatically. In new designs or major refurbishments, fire doors on busy routes, particularly where chemicals and equipment are regularly carried, should be designed with hold-open devices that automatically release the doors when the fire alarm sounds.

Any plastic materials used in laboratories or preparation rooms for construction (eg, ceiling tiles), storage containers, sinks, lampshades and electrical conduits etc. should not be readily flammable.

> *A small fire was spread dangerously by flames melting overhead plastic lampshades that then dripped over the benches*.

Curtains or blinds should be of a flame-retardant material. Beware also of the dangers of Bunsen burners under shelves, next to wall posters or beneath paper or card models and similar items hanging from the ceiling.

Carelessly-placed equipment acting as lenses, eg water-filled flasks or lenses in overhead projectors etc, can focus sunlight and so cause fires.

> *In one school, water in a 500 cm^3 round-bottomed flask used to demonstrate the working of the eye converged sunlight sufficiently to scorch a piece of paper. Fortunately, this was discovered just before a fire started. A second school was not so fortunate!*

The location of mains switches for electricity and stopcocks for gas and water should be clearly indicated and known to all teachers and technicians working in the laboratories.

> *In a practical class, a child lit the gas at the gas tap producing a flame 1 m in length. Acting in haste the teacher turned on the adjacent tap, resulting in two gas flames. Thus prevented from reaching the taps again, the teacher then had to hunt for the stopcock in order to cut the supply to that bench.*

Experienced teachers have a duty to give guidance in safe practice to their newly-qualified or trainee teacher colleagues and to laboratory technicians. The practice of teaching across the sciences can sometimes result in a teacher handling unfamiliar chemicals in unaccustomed ways. Here again it is the duty of the head of department or equivalent to ensure that all concerned are adequately informed of hazards and safe techniques. The importance of instruction in sound handling techniques and good practice cannot be over-emphasized. Staff should be instructed/reminded of the need to:

- check Bunsen burner tubing for signs of cracking;
- check glassware for faults;

- make sure charcoal blocks are safe to leave after use;
- wash down surfaces contaminated with oxidising agents;
- ensure vapour does not build up in laboratories or chemical store rooms by checking for adequate ventilation.

Heads of Science should also ensure that only minimum quantities (e.g.100 cm^3) of flammables are available in a laboratory at any time and that teachers and students are trained to cope with small fires such as those in test tubes or beakers. Particularly useful in this respect is *Safe and Exciting Science*[2]*,* the ASE pack of training activities on health and safety for science departments, which has a section designed to be used to train new staff in dealing with minor fires.

Rubbish must not be allowed to accumulate, particularly under benches or in stairwells. Waste bins should be of metal and be emptied daily but hazardous materials must be rendered safe before being left for disposal. Under no circumstances should oxidising agents be placed in the waste bin.

> *A school cleaner started a fire in a bin containing paper towels when she tipped in manganate(VII) (permanganate) from one waste bin followed by broken glass. This came from a flask which had been deposited in another bin in a different laboratory and which had originally contained propane-1, 2, 3-triol (glycerol).*

8.4 Outbreak of Fire

If a fire does start, the top priority must always be the safety of people: **everything else is secondary to this**. Smoke and toxic gases can spread very rapidly and cause panic; the smoke and toxic gases can cause severe respiratory injuries and fatalities.

However, small fires can be tackled and some fire officers encourage this – after all, why otherwise go to the expense of providing fire extinguishers? The Government's guidance[3] confirms that the first priority should be to raise the alarm to ensure that all students, staff and visitors are safely evacuated but in section 3.4.2 it goes on to add the following.

> 'Firefighting equipment can reduce the risk of a small fire, e.g. a fire in a waste-paper bin, developing into a large one. The safe use of an appropriate fire extinguisher to control a fire in its early stages can also significantly reduce the risk to other people in the premises ... '

Consequently, it is important then that science staff receive training on when a fire can be tackled safely and how it should be tackled.

All establishments must have a clearly-stated procedure for dealing with such emergencies and this must be known by all teachers, ancillary staff and students. A summary should be prominently displayed in all rooms in a fire notice. This should be brief and clear enough to be readily understood by anyone new to the building.

Fire exits must be clearly marked with a fire-exit sign that includes a running person and door pictogram[4], unless the exit is immediately obvious and there is no realistic possibility of it becoming confused with another route which is not a fire exit. Emergency exits must be kept free from obstruction at all times.

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[2] *Safe and Exciting Science. A pack of training activities on Health and Safety for Science Departments in Secondary Schools and Colleges and for Initial Teacher Training, Induction, etc*, 2nd edition, 2009. ISBN 978 0 86357 423 8. See especially *Unit 3D Fire*.

[3] *Fire Safety Risk Assessment - Educational Premises*, Department for Communities and Local Government. See http://www.communities.gov.uk/publications/fire/firesafetyrisk6.

[4] Complying with *The Health and Safety (Safety Signs and Signals) Regulations* or equivalent British or European Standard.

If the Fire and Rescue Service is called, be prepared to give any information that may be required such as where stocks of flammable solvents are stored. If you have animals in the science area, tell the Fire and Rescue Service so that they can be considered for rescue once all people are accounted for and safely out of the buildings.

The *Management Regulations*[5] require that a member of staff be nominated to implement evacuation procedures.

8.5 Fire-Fighting Equipment

Each laboratory and preparation room should be provided with a fire blanket and the means of extinguishing a small fire: one carbon dioxide fire extinguisher of 4 to 5 kg or two of 2 kg capacity is the most suitable.

However, sand is necessary for dealing with alkali metal and phosphorus fires. ‘Sand buckets’ tend to be used as a receptacle for all manner of things and are best avoided. Clean dry sand (say, about 1 kg) can be brought into the laboratory in a container labelled “Dry sand, for extinguishing phosphorus and alkali metal fires” by the technician along with the chemical(s) being used.

The discharge from dry powder extinguishers can ruin computers and sensitive electronic equipment and is very messy to clean up. Foam extinguishers are also unsuitable because of the amount of electrical equipment in most laboratories. ‘Hydrospray’ extinguishers are essentially water with a special additive and carefully-designed nozzle and are safe if used accidentally on an electrical fire but would not be recommended for deliberate use on such fires.

Ideally, fire-fighting equipment should normally be in the laboratory and situated close to an exit door. However, in some schools this may make it vulnerable to vandalism from students in the corridor or as students leave the room, in which case the fire risk assessment may conclude that siting it adjacent to the teacher base is preferable.

All such items must be regularly inspected and maintained in accordance with the requirements of the employer and the fire risk assessment. This is not normally the responsibility of the science department. After use, any equipment must be serviced in accordance with the supplier’s recommendation.

Any extinguisher must be used with the utmost care in the vicinity of animal enclosures.

8.6 Some Particular Hazards

8.6.1 Fuel gases

It is imperative that there should be no leaks in the fuel gas system; any odour of unburned gas must be investigated immediately and rectified before classes continue.

> *In one school, steel gas pipes were buried in the floor in a concrete screed. Eventually, after many years of complaints about gas smells, the floor was dug up and the pipes found to be seriously corroded, a classic case of iron corroding, unseen, at some distance from those parts of the iron exposed to air.*

Guidance from the Institution of Gas Engineers (and the former DfES) requires that each room should have its own gas cut-off, close to where the supply enters the room. This could be a simple lever or spanner-operated valve, or a push-button-operated solenoid valve. For lever or spanner-

[5] *Management of Health and Safety at Work Regulations*, 1999, SI No. 1999/3242, Stationery Office. See also *Approved Code of Practice and Guidance L21: Management of Health and Safety at Work*, HSE, 2000. ISBN 0 7176 2488 9.

operated valve cut-offs, the ‘off’ position should be marked clearly. Whilst fitting cut-off valves retrospectively in some existing laboratories could be expensive, it is essential in any new building or major refurbishment. If the gas cut-off is not in the laboratory, there needs to be clear information on a durable sheet on the laboratory wall to say where the gas cut-off can be found. (The information could also include the location of the electrical isolator and water stopcock for the laboratory if their locations are not obvious.) However, if the gas cut-off is remote and difficult to access, eg if it is in a locked cupboard elsewhere in the building, such that the gas could not be turned off promptly in an emergency, then it is a priority that a gas cut-off is installed where it can be accessed quickly in the laboratory.

Where a gas cut-off turns off the supply to several areas, this should be indicated clearly by a durable information sheet fixed next to the valve.

> *In one school, the gas supply to a laboratory and a prep room shared the same cut-off, in the laboratory. A teacher cut off the gas in the lab, not realising that a gas ring was in use in the prep room. When the gas was later turned back on, the prep room started to fill with gas.*

Flexible pipes (e.g., Bunsen burner tubing) should be regularly checked and replaced if there is evidence of damage or poor fit.

> *Several incidents were reported when using a faulty batch of black neoprene Bunsen burner tubing with reinforced ends. The vulcanisation process that seals the wider-bore ends to the main tubing had been defective, resulting in gas leaks at the join.*

Avoid using **thick**-walled neoprene tubing as it is too rigid and may cause Bunsen burners to be knocked over. Thin-walled neoprene tubing (often coloured grey) is satisfactory. Rubber tubing does have a tendency to leak when exposed to methane over a period of time so needs checking from time to time.

Extra vigilance is required if liquefied petroleum gas (LPG) is used as the fuel source. Unlike natural gas (methane), LPG (propane or butane) is denser than air and will sink to floor level; it may then accumulate in conduits or other underfloor cavities. Small cylinders are sometimes fitted in mobile benches but the Institution of Gas Engineers advises against this although the definition of ‘small’ in this context is unclear. Bunsen burners fueled by cartridges are best avoided except for occasional demonstrations or in emergencies. Where an appliance requires an integral gas bottle or cartridge, such containers should be changed and used only in strict accordance with the supplier’s instructions. If LPG is used, it is preferable to have piped supplies. In that case, the cylinders will be large and the fire risk assessment will require outside installation. All such piping will need to be inspected on a regular basis.

> *An explosion that wrecked the laboratory of a rural school, which used bottled gas, was caused by ignition of butane in an underfloor service duct. The gaseous butane had escaped from a leaking screw-thread connection between a gas tap and its service pipe and collected below the floor. Students who succeeded in rotating the gas tap on the bench after removing the restraining woodscrews had caused the original leak.*

Modern designs of gas tap are available with integral anti-rotation devices to obviate such problems.

Some laboratories are equipped with lightweight island bench units with fixed, rigid service pipes.

> *In one incident, movement of the island unit had caused a leak in the gas pipe below the bench, allowing gas to fill the space between the drawers. Eventually a flashover occurred when a student was using a Bunsen burner and the whole unit became engulfed in flame.*

8.6.2 Ethanol

Ethanol in school science is usually in the form of industrial denatured alcohol (IDA) - formerly known as industrial methylated spirit (IMS). Occasionally schools may use ethanol in the form of completely denatured alcohol (CDA) – the purple tinted methylated spirit available from hardware stores. The term ethanol is used generically in the following paragraphs.

A number of accidents resulting in burns have been reported which involved ethanol. In the most serious instances, it was being used as a fuel in burners for **model steam engines**.

> *In one reported case a teacher, believing the fuel to be exhausted and the flame to have gone out, was attempting to refill the trough-type burner with ethanol when it ignited, causing a flash fire and severe burns to pupils sitting about 1 m from the demonstration bench.*

There were at least five similar reported accidents in a relatively short time so the use of ethanol as a fuel for model steam engines presents an unacceptable (and unnecessary) hazard. The best solution is to use a burner specially designed for a solid fuel, such as hexamine or Meta fuel. Burners intended for solid fuels should never be used with liquid fuels.

Ethanol and other alcohols are sometimes used in **spirit burners**. We do not recommend spirit burners for general heating purposes but they can be used with care when comparing the calorific value of different fuels. Spirit burners should be placed on the bench, never held in the hand, and should be lit with a lighted spill or match. A lighted spirit burner should not be moved around the laboratory. Spirit burners should be filled only by the technician in the prep room and refilled there when cool, and never in the laboratory.

> *A school, which was temporarily without a gas supply, used spirit burners as a substitute for Bunsen burners. To light his burner, a boy went to an already-lighted burner and tipped the wick towards the flame. The alcohol in the burner spilled out and caught fire. The fire burnt the hair of a girl standing close by; she was only slightly injured and made a full recovery.*
> *A second school experienced a small explosion with methanol. In this case the wick was much narrower than the hole in which it fits, thereby creating a gap between the wick and the holder. When the burner was only partially filled with methanol, there was an air/methanol mixture in the vessel which was ignited through the gap.*

The wick holder should be a tight fit in the neck of the burner and the wick itself should be tight in the holder. Some burners have a large capacity. It is best to reduce the capacity of such burners by partially filling, eg with sand or a resin or lessening the risk of spills by packing with cotton wool.

Fires involving ethanol are not confined to its use as a fuel.

> *A technician was decanting ethanol after boiling with grass to extract chlorophyll; the liquid ignited causing severe burns to the person holding the vessel.*
> *In another instance, a pupil was badly burned when attempting to fill a 'home-made' thermometer with ethanol by heating the bulb in a flame whilst the open end was dipped into the liquid*.

8.6.3 Heating flammable liquids

Particular care must be exercised when it is necessary to heat a flammable liquid. Only the absolute minimum volume required should be used, contained in a vessel no more than one fifth full.

A bath of hot water is often a satisfactory heat source but the water should not be heated with a naked flame or hot plate on the same bench as these liquids to avoid the risk of igniting the flammable vapour. An electric kettle or thermostatically-controlled water bath is a convenient source of hot water for school laboratory purposes. For higher temperatures, a sand tray or hot plate will need to be used.

There are various definitions of highly flammable, all depending on the specification of a flash point. A table listing flammable and highly flammable liquids that might be used in school laboratories with their flash points and auto-ignition temperatures is now available under the *Health & Safety - Chemistry Resources* tab on the members' part of the ASE web site[6]. Many of the liquids in the table are capable of producing a vapour-air mixture that could be ignited by a spark even at room temperature. There have been instances reported of explosions caused by ignition of flammable vapour-air mixtures by arcing thermostat contacts.

> *A laboratory drying oven was completely wrecked by a solvent explosion. A spark in the thermostat ignited the vapour produced by evaporation of the final traces of solvent from crystals.*

Several instances are known of similar explosions occurring when flammable solvents had been placed in refrigerators: domestic refrigerators do not usually have spark-proof thermostats. All electrical equipment, which may come into contact with flammable vapours, must be fitted with spark-proof switchgear. Note, however, that this does ***not*** normally mean that spark-proof switches must be fitted in chemical store-rooms.

8.6.4 Class practical work

There has always been a fire hazard associated with some **clothing materials** but many light-weight synthetic fabrics are particularly prone to burn if in contact even momentarily with a Bunsen burner flame or splashed with a burning liquid. This includes the most common type of laboratory coats, made with about 65% polyester, which, contrary to expectation, do not give good fire protection.

Some years ago, there were several reported accidents in which a student's **hair had caught fire**. Hair normally singes when in a flame but some styling preparations can cause it to burn instead. Investigations by CLEAPSS suggested that many lacquers (holding or fixing sprays) and mousses (frothy preparations from aerosols) increase the flammability of hair. Gels (in pump-action dispensers, tubes or jars intended to make hair look wet or shiny) are relatively safe and render hair non-flammable until they have dried out. There is some evidence that styles in which hair is in tufts or separate strands increases the tendency for hair to catch fire (increased surface area!). Students should be advised not to spray their hair at school (so that the solvent/propellant may have some chance to disperse) and also to keep hair, goggle straps, ties and scarves well away from Bunsen burners or other naked flames.

> *Quite recently, a pupil was using a pin-hole camera to look at a candle flame when her hair caught fire. She had long hair but it is not clear whether she had tied it back.*

The risks of **candles and night-lights** (tea lights) are under-estimated, perhaps because of their familiarity in everyday life.

> *In one of the few science accidents which resulted in a criminal prosecution under the* Health & Safety at Work, etc Act*, a 12 year-old pupil was badly burned. He was timing how long a candle took to go out when covered by beakers of various sizes. His shirt caught fire as he was leaning over the candle. Whilst it was not entirely clear what happened, probably he was wearing a rather baggy shirt which hung into the candle flame.*

Schools often use heat-proof mats, although they would be better described as **heat-resistant mats**. These are intended only to protect the bench from reflected heat, or if hot objects are put on them, and should not be heated directly by a Bunsen burner flame.

[6] *Flash points and auto-ignition temperatures*, available at http://www.ase.org.uk/documents/flash-points/

In one school, the bench beneath the mat caught fire when a lump of calcium carbonate was heated strongly on it.
In another school, a mat exploded when a tin lid on it was heated directly.

Illicit experiments can also be a fire hazard. For example, some pencil sharpeners, made of magnesium, have been ignited all too successfully!

8.6.5 Demonstrations

Nearly all the serious accidents occur during demonstrations.

It is very important that the teacher should at all times demonstrate safe techniques and never be seen to take chances. Eye protection must be used by both teacher and students, together with suitably positioned safety screens, whenever an experiment, which might result in an explosion, is to be performed.

Explosions involving hydrogen gas continue to occur. The most usual cause is failure to expel all air from the apparatus before igniting the hydrogen. Ways of avoiding this problem were given in a *SSR* article now available under the *Health & Safety Resources - Chemistry* tab on the members' part of the ASE web site[7].

Ignition of students' clothing has already been mentioned (see 8.6.4) but **teachers' lab. coats** are also vulnerable.

A teacher was wearing a polyester/cotton mixture lab. coat (67% polyester) that caught fire as she leaned over a non-luminous Bunsen burner flame (on a sunny day!). The molten fibres severely burnt her arm and body.

Laboratory coats made of heavy-duty cotton are less easily ignited but are not widely available and are less comfortable to wear. Substances such as Proban are available to treat lab. coats to render them flame retardant. Coats made of pure polyester are more fire-resistant than polyester/cotton blends but the hot fabric can cause burns if it melts and drips. If lab. coats are worn they should be buttoned up (see *Topic 5*).

Inappropriate use of fume cupboards has resulted in fires.

A teacher was carrying out the howling jelly baby demonstration in a recirculatory (filter) fume cupboard. The cupboard caught fire because sparks from the demonstration were sucked onto the pre-filter, which is made of paper. The main (carbon) filter was damaged as well. There would be a risk of a similar incident if demonstrations involving the thermite reaction or 'cannon fire' were carried out in such fume cupboards. Although producing smoke, all these demonstrations should be carried out in the open laboratory, behind safety screens, not in a fume cupboard.

Some of the demonstrations involving ethanol fires (see 8.6.2) resulted in students' clothing being ignited, causing serious burns. Because of the risk of unexpected incidents, including fires, explosions, etc, students should never be seated too close to the demonstration bench: 2 - 3 m is usually a suitable minimum gap.

8.6.6 Clearing away

Problems can also arise in clearing away after an experiment.

A fire started in one laboratory, when small pieces of phosphorus ignited in a plastic sink, thereby causing the plastic to burn as well.

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[7] *School Science Review* 215 (December 1979) *Hydrogen*, available **at** http://www.ase.org.uk/resources/health-and-safety-resources/health-and-safety-chemistry/

Disposing of **alkali metals** has caused problems.

> *One accident arose when a bottle containing an aged sample of sodium was rinsed with water, the metal exploding and starting a fire that rapidly spread.*
> *In another school, a technician was trying to dispose of some old potassium by dropping it into 2-methylpropan-2-ol (t-butyl alcohol). As it had a yellow coating, he couldn't cut it up into small pieces so the whole lump (nearly 8g) went into about 200 ml of the alcohol. The reaction was very violent, the mixture caught fire and there were choking white fumes.*

If it is not safe to cut up the potassium, the reaction can be slowed down by mixing the alcohol with an equal volume of an inert solvent such as liquid (medicinal) paraffin. It must be carried out in a beaker much larger than the volume of liquid and, as lumps may take many hours to react fully, the beaker must be left in a safe place for some time, clearly labelled.

Blocks of charcoal can smoulder unseen for a long time after use even after dousing with water.

> *Although less commonly used than in the past, even in recent years fires have been caused by ignition of charcoal blocks returned to a store cupboard before being completely cold.*
> *Charcoal blocks are best stored in a metal container with a well-fitting lid and not returned to the store for at least 24 hours after use.*

8.6.7 Newly-published texts, courses, and the Internet

Many newly-published courses now include health and safety advice. It is the duty of the head of science to ensure that, notwithstanding the advice given, the activities suggested in the text do not present an unacceptable fire risk.

YouTube and other Internet sites can be a source of interesting ideas for practical activities, but beware of some foolish and dangerous activities that could lead to serious fires. If your employer has not supplied a suitable risk assessment, members could contact CLEAPSS[8], SSERC[9] (in Scotland) or ASE[10].

8.6.8 Ruben's Tube

Ruben's tube will hold several litres of extremely flammable gas and it is essential to control the risks of explosion and serious fire. Do not use designs from the Internet, many are dangerous. Members can access details of the CLEAPSS[11] design (see CLEAPSS guidance leaflet PS85) which is suitable for schools to use, with care.

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[8] CLEAPSS, The Gardiner Building, Brunel Science Park, Kingston Lane, Uxbridge UB8 3PQ.
Tel: 01895 251496; *Fax:* 01895 814372; *E-mail:* science@cleapss.org.uk; ***Website:*** www.cleapss.org.uk.
Membership is open to education authorities, and hence all of their schools, throughout the UK (except Scotland). Independent schools and colleges, including academies and free schools, and teacher-training establishments may join as associate members.

[9] SSERC, 2 Pitreavie Court, South Pitreavie Business Park, Dunfermline, Fife KY11 8UB.
Tel: 01383 626070; *Fax:* 01383 842793; *E-mail:* sts@sserc.org.uk; *Website*: www.sserc.org.uk
Membership is open to education authorities, and hence all of their schools, in Scotland. Independent establishments may also subscribe.

[10] The Association for Science Education (ASE), College Lane, Hatfield, Herts AL10 9AA.
Tel: 01707 283000; *Fax:* 01707 266532; *E-mail:* info@ase.org.uk; ***Website:*** www.ase.org.uk. Membership is open to anyone interested in science education.

[11] http://www.cleapss.org.uk/secondary/secondary-science/secondary-science-guidance-leaflets

8.7 Fighting Small Fires

Teachers, technicians and indeed students using school laboratories need to know how to tackle *small* fires, which are quite common in laboratories. However, staff should never endanger themselves or others. If the fire is not rapidly extinguished, evacuation is the only option. Training of staff in dealing with small fires should form a natural part of departmental meetings and similarly training of students should form a natural part of day to day teaching.

Fire and Rescue Services and equipment suppliers run courses and it is suggested that at least some science teaching and support staff at a school be encouraged to attend one of these, although normally the scale of laboratory fires starts off much smaller and, with prompt and appropriate treatment, stays that way. The advice in the following paragraphs could form the basis of local rules.

Burning furnishings

Tackle only in the initial stages. If gaining a hold, the priority is evacuation of students and staff.

Flammable liquid fires

If the flammable liquid is **burning in a container such as a beaker**, the preferred first treatment is to cover with a bench mat or damp cloth (or smother with a fire blanket). If the volume of flammable liquid is small, it is probably safer to leave it to burn out by itself. The use of fire blankets can, in inexperienced hands, create problems, as they tend to be awkward to handle and may spread a small fire by knocking over the apparatus containing the burning liquid. If smothering does not extinguish the fire, a carbon dioxide extinguisher may then be necessary. This also needs care because if an extinguisher is held too close to a container of burning liquid, the blast of carbon dioxide is likely to send the container and burning contents flying. Hence training on extinguisher use is advisable; see the section on training. If a blanket *is* used it should be left in place while the area cools.

If **spilt liquid is on fire**, it may be possible to allow it to burn out. Alternatively, smothering is possible. If a fire extinguisher is used, direct it towards the edge of the fire and sweep towards the centre. Two persons can better tackle larger fires, each with an extinguisher from different angles but not directly opposite each other.

If **burning liquid is spilt on a person's clothes**, "stop, drop and roll". This means the individual should stop moving around, be made to lie down and rolled in a fire blanket (or more easily accessible substitute, eg a lab. coat). If rolling is impractical, the flames should be on top in order to burn away from the body.

Gas fires

A fire extinguisher should not be used on the gas jet. Shut off the gas supply and use the extinguisher only on residual fires that may be burning after the gas has ceased to flow.

Hydrogen cylinders: if safe to approach, shut off the gas supply at the main cylinder valve. The key should be on the valve at all times for this purpose. If for any reason this is not possible, evacuate the area.

Natural gas: if safe to approach, shut off the supply at the bench gas tap. The main gas cut-off may have to be used and it is better if it is close by.

Metal fires

Small fires **involving sodium, potassium, calcium, lithium, aluminium or magnesium**. (**Note:** eye protection should already be in use.) Smother with a large excess of dry sand, ***not*** a carbon dioxide extinguisher (which may react, if the metal is hot enough). Leave to cool. Sand containing sodium residues should be disposed of in propan-2-ol and potassium residues in 2-methyl propan-2-ol. In all cases, the contaminated sand should afterwards be cautiously added to a bucket of water in a fume cupboard, to decompose silicides formed. Spontaneously-flammable gases may form at this stage but do not present a significant risk in an efficient fume cupboard.

Phosphorus fires

Water is a suitable extinguishing medium for phosphorus fires and red phosphorus is straightforward to handle but white (or yellow) phosphorus burns fiercely and can re-ignite spontaneously.
It is most convenient, usually, to cover the burning phosphorus with wet sand. The sand and phosphorus residue can then be treated by allowing to stand, with occasional stirring, in a fume cupboard with 1 mol dm^{-3} copper(II) sulfate(VI) solution. This converts the phosphorus to copper(II) phosphide. After a week, filter off the solid and, whilst still wet, add it to excess 5% sodium chlorate(I) (hypochlorite) or bleach to oxidize it to phosphate, after which the solution can be diluted and poured down the drain.