STS

Scope includes Science, Technology and Safety

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A Risk Assessment Special

Essential tools to help you climb the risk assessment steps

Assessing risks

Recent incidents have led the Health and Safety Executive and ourselves to review the use of generic risk assessments in school science and technology teaching. This article updates our earlier advice on such matters. The key messages are that whilst it is foolish to rely solely on amassing paperwork, it is equally unwise to be left administratively naked without clear evidence that active steps have been taken not only to assess risks but also to control any which have been judged significant.

Note: Prior to the McCrone Agreement this advice would have been addressed to Principal Teachers. Now we judge it might well be aimed at Heads of Curriculum or whatever other designations may be appropriate in the particular middle management model adopted by the school.

The Law

The Health and Safety at Work Act placed a major legal duty on any employer. It is that of ensuring that arrangements at work are as safe as reasonably practicable, meaning that risks are assessed and controlled. These requirements go back more than thirty years to 1974, when the Act was introduced, and beyond. This core duty is subject to the condition of "as far as is reasonably practicable". This was made explicit in the Management Regulations when they came into effect in 1993 and were later updated in 1999. (Please see next article on page 6 for an interpretation of "reasonably practicable".)

It follows that work related activities have to be assessed for risks to the health and safety of employees and to others that may be affected. This is a statutory requirement. It includes experiments and other practical activities in science and technology courses. You may continue to depend on applications of the results of generic risk assessments, but if you do, it is necessary to ensure that these are "suitable and sufficient". Otherwise, adapt them for your needs. Where there are no generic assessments to rely upon, risks still have to be assessed. An approach based on first principles has then to be adopted. The overriding need, however, is for action. Identification of any significant risks is merely the end of a beginning. Steps must then be taken to put in place sensible, practical, preventive and protective measures. Preventive measures are taken before the event to decrease probability of occurrence. Protective measures are intended to ameliorate matters should things "ging oot the windae".

Advice to date

From 1993 onward, SSERC has been advising schools to apply a three-tier scheme to assessing risks. For a simple procedure – one well within the ken of the science or technical teacher – it is sufficient to make a mental assessment. This can draw on previous knowledge and experience or on information provided on a container or the apparatus itself. The results of such an assessment need not be recorded. For a not-so-simple procedure, say, for a standard experiment or operation, it is sufficient to apply the results of a generic risk assessment. These should be taken from a reputable source. A list of examples of such sources is appended to this article (Table 2). Where the generic description does not match the apparatus or method in use, then we advised annotated amendment of the generic risk assessment in manuscript. Finally, for a not-so-simple or novel procedure, or one for which there is no generic risk assessment, we have been telling you that you would have to do your own assessment, recording the results in writing. To help you do that some of our publications have provided guidance on assessing risks in activities that use hazardous substances (including micro-organisms) [4]. At that time, relatively few activities fell into this third category.

Revised advice

That advice now needs to be updated. Be reassured. We think that you should continue to rely fairly heavily on generic risk assessments. You may now also have to do more yourselves to assess risks and make it evident that you are indeed taking generic risk assessments and adapting them for your own needs. For one thing, your employer may now be insisting on a risk assessment for each experiment. You'd best heed the old Cold War advice and "Visit Russia before Russia visits you". For another, the law related to management issues, which has now been in place for more than ten years, is abundantly clear. Work activities must be risk assessed. They must be as safe as is reasonably practicable. It could be argued, initially, that teachers should rely largely on second-hand risk assessments. This argument provided a useful preparatory period, one that should have allowed schools and colleges to put in place suitable systems. Now, however, whilst still relying largely on results from generic risk assessments, you will need also to show that you have not merely accepted that the assessments cover all eventualities. Therefore evidence is needed to demonstrate that you have actively adopted, and where necessary adapted, the practical measures needed to control any significant risks.

Recent incidents where burns to pupils resulted from the use of candles show how easily injury can occur even in a seemingly simple, routine activity. One of these incidents was described in Bulletin 212 [5]; the other is the subject of another article in this issue. These events also illustrate the vulnerability of both schools and staff if they cannot demonstrate that they've assessed an activity out of which an incident arises. This is especially so in the absence of systematic procedures to assess all of the practical activities. Updated advice on how to assess activities for significant risk follows.

Generic assessments

For many years, we have all used the results of generic assessments. This has largely proved a sensible approach; it saves work. Having extremely busy teachers and technicians all duplicating the same work is both pointless and wasteful. It seems sensible to share. There is nothing wrong with sharing except that it brings a danger of thought-less routine. The procedural means may then obscure the practical ends of the task. The use of generic risk assessments should not be a "'TICK'. Job done." affair. It is important not to blindly accept results from such an assessment. You need to think critically about it, and how you might actually apply it. Is it good enough? Are there any other hazards or risks not covered in the activity? Can the assessment be improved? Are some bits of the generic assessment over the top? Do they focus overmuch on trivial risks? In which case, such elements should be removed so as to avoid such low-level noise masking some of the higher risks.

A major problem with generic assessments is obscurity and thus inaccessibility. They may be scattered hither and yon in dozens of *Bulletins*, books and CDs. They may need to be excavated and put out on show so as to be readily consulted by whosoever needs to do so whenever and wherever there is a need. Partly in recognition of this problem, SSERC is working on a *SafetyNet CD ROM* for issuing to schools which will encompass updated information from the *Hazardous Chemicals An Interactive Manual CD2*, *Microbiological Techniques CD1 An Interactive Manual*, and a range of other sources of risk assessment results.

Other problems with generic assessments include:

- Ownership - how do you adopt a generic assessment so that it becomes the one your department owns and actually uses?
- Telling others - how is anyone who needs to know made aware that this is the departmental risk assessment for a particular activity?
- Over-dependence on underlying fundamental practices such as 'Good Laboratory Practice/ Hygiene' and 'Immediate Remedial Measures' can result in risks being dismissed as trivial, routine and merely to be 'put up with'. Bad practice then may go unrecognized.

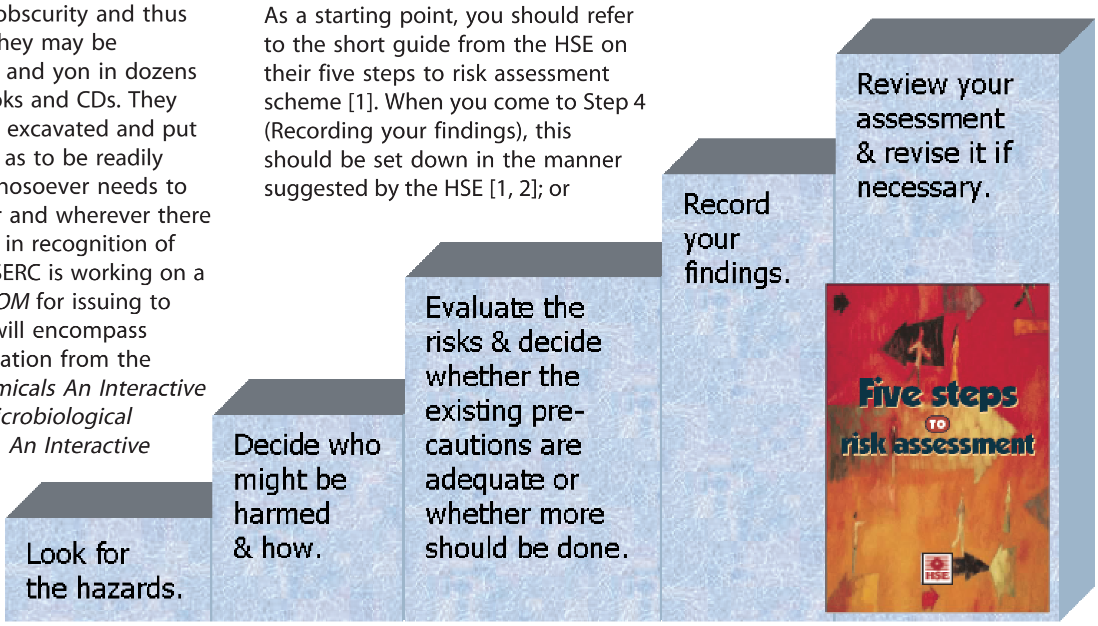
One means of addressing all of these issues would be to test those generic assessments, and the results from them which you want to adopt, against the HSE's own *Five Steps to Risk Assessment* approach. This scheme meets the legal requirement that every work activity must be risk assessed, but still allows you to exercise judgement. It doesn't prevent you depending for a lot of the slog on generic assessments prepared by external safety specialists.

Assessing risks from practical activities

As a starting point, you should refer to the short guide from the HSE on their five steps to risk assessment scheme [1]. When you come to Step 4 (Recording your findings), this should be set down in the manner suggested by the HSE [1, 2]; or perhaps using a simplified template from SSERC [3]. A worked example is given at the end of the article on Compost Columns in the Biology Notes of this issue.

Step 1: This is the identification of the hazards. (Note that a hazard is the potential to cause harm. Therefore the commonly used phrase "Potential hazards" should not be used.) For this part, list the significant hazards and ignore any trivial dangers.

Step 2: Ask yourself who might be harmed? Obviously the pupils might be harmed, but do remember that accidents are more likely to happen to staff. Although we don't have statistical evidence to support our conjecture, we also think that technicians are probably more at risk than teachers. This is because they routinely handle stock bottles and are more heavily engaged in practical preparatory work. They are continually moving to and fro, which puts them at risk of tripping or slipping. In some cases they may spend significant periods of their time working alone. Health and safety legislation affects all persons at work in your school (e.g. teachers, technicians, office staff, cleaners, janitors etc.) and other persons affected by school work conditions (e.g. schoolchildren, visitors, community education folk). Raise your sights to include anyone who might reasonably be judged at risk – child and teacher, certainly; technician, very probably; others,



occasionally. Some of these persons might be exposed to all of the hazards, others to just some of the hazards. Your record should show which groups of people are exposed to the hazards that have been identified.

Step 3: Is more needed to control the risk? This is where you may have to be creative. Firstly, weigh up the educational benefits against the risks. Is the experiment or investigation justifiable? If there is little or no educational worth in it, don't do it. At least don't do it that way. If, on the other hand, the educational benefits are greatly prized, then it would be worth putting in the time and effort into getting it done safely. One important bit of practical advice is to get out the apparatus or other kit and do the experiment (or other work activity) that is to be assessed. That will tend to make you think more about what to do. It will make you more aware of the hazards, and strengths and weaknesses of equipment, materials and methods. You are then less likely to overlook things of importance.

Think of the hierarchy of control measures (from best or most severe to weakest:

1. Eliminate - don't do the experiment, investigation or work activity. Apply such an elimination control only as an extreme measure. There generally shouldn't be any need to ban any practical activities that are, at present, regularly done.

2. Replace the hazardous material or procedure with a safer one – for instance:

- replace a protactinium generator with a caesium/barium isotope type to show radioactive decay (see Bulletin 211[6]);
- for cooling curve experiments, replace naphthalene, which is readily absorbed by inhalation and skin contact and is harmful, with long chain alkanols or alkanoic acids, such as octa-decanol or octadecanoic acid; and melt them not in a direct Bunsen flame, but hold the tube in a beaker of hot water, to limit the escape of fumes;
- use a coloured strain of yeast (*Phaffia rhodozyma*) rather than of a bacterium to demonstrate microbial transfer by hand-shaking.

3. Engineering controls – an excellent control measure, but one that usually has to be done by the equipment manufacturer. For instance:

- because of the product design, it is virtually impossible for Class 2 laser radiation to cause permanent harm to eyesight; the danger has been engineered out;
- when working with an HT power supply, for example in electrophoresis of DNA or proteins, use shrouded connectors to prevent anyone touching dangerous conductors;
- in workshops or elsewhere use properly designed extra low-voltage portable power tools.

4. Enclose the experiment or activity – if taken to its extreme, any demonstration would be hidden from sight and would be of little educational worth. Protective covers and guards on machine tools in workshops and prudent physical barriers in demonstration experiments are undoubtedly useful. Where there is a risk of a violent reaction or explosion, the children and teacher can be protected by pairs of safety screens. Other examples where protective enclosures help are in:

- carrying out the dissolution of rocks or metals by hot hydrochloric acid in a fume cupboard;
- doing an organic reaction in a flask fitted with a reflux condenser to prevent vapour escaping;
- containing microbial cultures by taping Petri dishes after inoculation;

5. Reduce the scale, lower the risk – for instance by:

- running an HT transmission line model at 30 V instead of 240 V;
- using 0.1M sodium hydroxide in place of a 2M solution for most applications;
- growing micro-organisms on a small scale in McCartney bottles or Petri dishes as the default procedures, unless the use of a bioreactor (fermenter) is to be demonstrated.

6. Administrative procedures – rules of conduct (see examples below).

7. PPE - wear personal protective equipment. This is generally the weakest, and least desirable, of control measures, but necessary sometimes.

Think also of a number of administrative procedures e.g. :

- Teacher demonstration only.
- Teacher demonstration, or S5 or S6 only.
- Not for S1 or S2.
- Standing when working with a Bunsen, or hot water, or corrosive substances.
- Not allowing very hot water to be carried across the room.
- Forbidding the mixing of certain chemicals, for example, chlorates(V) and magnesium.
- Codes of practice for educational usage of living organisms and materials of living origin.
- Restricting the choice of micro-organisms for use, by way of example, for those without appropriate training.
- Before carrying out an activity in which sulphur dioxide may be released, checking for pupils and staff who may have asthma.
- Carefully rationing small pieces of magnesium (2-3 cm) for burning or reaction with acids.
- Forbidding the polymerisation of polyacrylamide gels for electrophoresis – either purchase precast gels, or use agarose.
- Arranging for samples of hydrogen prepared by pupils to be carried to the far side of the room for igniting.
- For certain activities, swapping the usual laboratory for one fitted with a fume cupboard.
- Restricting machine tool or power tool usage to defined user groups.
- Signing out and in radioactive sources or cultures of micro-organisms.
- Handling radioactive sources with tongs or tweezers.

- Instruction, with demonstration, before pupils are allowed to carry out a hazardous procedure such as aseptic transfers in microbiological work
- Training – see below.

Inform, instruct and train

This leads us on to the vital role played by information, instruction, training and supervision as measures to control risk (Table 1). Although these are all standard measures in teaching, they must be brought into the Step 3 part of risk assessing. Remember, too, that you are setting up control measures for a place of work. You may also have to provide information or instruction to teacher colleagues, technicians and cleaners in addition to what's needed for pupils or students.

Continuing with Step 3, you may need to look up safety references to ensure that the precautions you plan to take:

- meet any standards set by a legal requirement;
- comply with a recognized standard for the experiment (if one exists);
- represent good practice and is one that you are happy with; and
- reduce the risk as far as reasonably practicable.

Nevertheless be careful of using the results of risk assessments in published textbooks or worksheets; you cannot assume that they have been properly done. Be especially sceptical of information you get off the Web. While some of the information is from reputable sources, much of it has not been peer-reviewed; much is placed there by pressure groups, or people with a message to sell or a particular line to plug.

Control measure	Comment and examples
Information	Poster with safety rules on lab or workshop wall. Copy of lab or workshop safety rules in each pupil's file or jotter. Notice for staff on what they should know and do on working with radioactive sources.
Instruction	Demonstration of a procedure, which should also explain what might go wrong if the procedure is not followed. Remember that staff need instructions too. Sets of written instructions on experimental workcards.
Training	A repeated cycle of instruction and practice under supervision. For example, microbiological technique and the safe use of hand tools or machine tools each depend on regular adequate training.
Supervision	Always necessary with children and adolescents. For some procedures, or for some groups, supervision has to be continuous; that is the teacher cannot leave the lab. For other procedures, or other groups, the supervision can be now and then as appropriate. The important point is that supervision must be suitable (appropriate to the specific circumstances) and sufficient (at the appropriate level or intensity).

Table 1 *Some comment and examples of the health and safety roles played by information, instruction, training and supervision.*

Step 4: Record your findings: A 2-page form based on "The 5 Steps …" by HSE can be downloaded from the SSERC website [3]. By all means use your own template, but beware of thoughtless computerese. Avoid sitting at a keyboard with a computer-based form copying and pasting from one activity risk assessment to another. That could well be worthless. Your best bet is a more common-sense approach. Get out the equipment and do the experiment or carry out the activity.

Source	Generic risk assessment or results	Format
ASE	Be safe! Safeguards in the school laboratory Topics in Safety	Booklet Book Book
BSI	BS4163 Health and safety for design and technology in schools and similar establishments - Code of practice	Booklet
CLEAPSS	Model risk assessments for design and technology in secondary schools and colleges	CD
SSERC	Hazardous Chemicals - An Interactive Manual Microbiological Techniques - An Interactive Manual Essential health & safety references for physics teachers Bulletin	CD2 CD1 Web Periodical & Web

Table 2 *Standard sources of results of generic risk assessments*

Once you have sorted out in your own mind what significant risks you need to control, then start to fill in the form with pencil or pen. Sketch out the apparatus or other equipment in the box marked "Description of activity" and annotate this with relevant comment. If you change your mind and score things out, don't worry. Should you ever be asked if you have assessed an activity, you'd have evidence that you've thought about what you were assessing and that you modified your first plans. This, not neatness, will look good.

Following on from Step 4, you must also inform others of your findings. This might require other teachers to look at your assessment. You might also give teachers and technicians your draft written guidance on how to do each experiment together with the findings of your risk assessments. If most of your teaching is oral, then there may be little need to prepare detailed written instructions. However, if your own teaching style is based on written material, then this should include the safety measures that pupils and students need to know about.

Step 5: Review and revision: No risk assessment is ever definitive. Like software, it will only ever be 99% complete. It is only prudent to review and rethink procedures. This is a legal requirement.

Finally, some thoughts on how to embed this whole business firmly into practice.

1. Initially, until you have built up your own set of risk assessments, you have to rely on the results of generic assessments in *Hazardous Chemicals An Interactive Manual CD2*, SSERC *Bulletins*, ASE *Safeguards in the school laboratory*, SSERC guidance on radioactivity, and so on. Annotate these, where necessary, for local conditions. See Table 2.

2. Enlist the support of colleagues. Employees are required by law to co-operate with their employer over health and safety arrangements. Although the prime duty and responsibilities always rest with the employer, health and safety tasks can legitimately be delegated to others so long as they are properly resourced. Risk assessing experiments is one area where it is reasonable to expect colleagues to assist. So don't try to do it all by yourself. Set up a team and work together.

3. Lots of experiments come in groups – e.g. heat, light, sound and magnetism. If you start by tackling a representative one from each group, you will have risk assessed all of the main areas of your teaching in quite a short time. The gaps can be filled in thereafter, but until they are, you and your staff can refer to the results of risk assessments that relate quite closely to whatever experiment you or they are doing.

4. Concentrate on the well-known high-risk activities – HT transmission line, pressurized vessels, boiling water, hydrogen, and so on – and get these assessments undertaken as a matter of urgency. See Table 3.

Examples of some well-known high-risk activities
Work with hydrogen - preparation; burning; reduction of metal oxides Diffusion of bromine; other reactions of bromine (technique of handling) Thermit reaction Enzymes and their allergenic reactions Infections from bacteria or fungi Applications of ethanol (or IMS) - historically the most important cause of laboratory fires, burns etc. Use of boiling water Pressurized vessels HT transmission line Mains electricity Use of hand or machine tools

Table 3 *High-risk activities*

References

1. *Five steps to risk assessing*, INDG163, HSE. http://www.hse.gov.uk/pubns/indg163.pdf
2. *A guide to risk assessment requirements, INDG218, HSE.* http://www.hse.gov.uk/pubns/indg218.pdf
3. *Risk assessment 5-step template*, SSERC. http://www.sserc.org.uk/
4. *Preparing COSHH Risk Assessments for Project Work in Schools*, SSERC, 1991.
5. *Accident with a pinhole camera* - SSERC Bulletin 212, p2.
6. *Safety guidance on radioactivity* - SSERC Bulletin 211, p3.

"Reasonably Practicable"

The main general duty placed on every employer by the Health and Safety at Work Act 1974 is to ensure, *so far as is reasonably practicable*, the health, safety and welfare at work of all employees. The interpretation of the phrase in parenthesis, '*so far as is reasonably practicable*' relies on a landmark judgement in a 1937 court case:

"…I am unable to take the view that it was reasonably practicable by any means to avoid or prevent the breach of section 55 (of the Coal Mines Act 1911). The time of non-protection is so short, and the time, trouble and expense of any other form of protection is so disproportionate, that I think the Defence is proved."

Thus if the elements of time, trouble and expense are all considered but found to be disproportionate to the risk, then it would not be reasonably practicable to reduce or remove the risk. An important inference to be drawn from this judgement is the need for evidence that, before any work activity has been begun, the hazards have been identified and the risks have been assessed. They have to be weighed against the time, trouble and expense of trying to ensure that no one can be harmed.

Therefore the need for assessing risk is based on 1930s case law and it predates the Health and Safety at Work Act by four decades. The main purpose of that Act was to protect all persons from work activities conditionally *as far as is reasonably practicable*. But note that one of the main purposes behind the Management Regulations was to impose an absolute duty on employers. This was to see that all of their work activities are risk assessed. Thus the prime means of setting a safe working environment is a strict, unconditional, legal duty. The ends however are conditional – everything reasonably possible must be done, taking into account the time, trouble and expense of the work but relative to the risk.

In any criminal prosecution brought under the Health and Safety at Work Act the burden of proof rests with the defendant. It is for the defence to prove that their actions met the condition of being carried through so far as was reasonably practicable. In doing that, the defence would need to rest on documentation prepared before any incident occurred. Where a school had not written down its results of a risk assessment, a defence would then have to rest on a school or teacher telling the court of the thought processes that had gone into the preparations for an activity. That of course would be the school's risk assessment. We think that the results of a generic risk assessment (taken, say, from a SSERC *Bulletin*, or the *Hazardous Chemicals Manual*, or *Safeguards* …) would be suitable and sufficient, provided always that the school could also prove that it had been looked at, thought about and followed. Nevertheless, it is important to remember, firstly, that only the courts can decide such matters and, secondly, that this opinion has never been tested in front of a jury.

Not proven

Chemistry lesson disaster sees school in the dock

A 12-year-old boy received third-degree burns in a school experiment, Norwich Crown Court heard. In a joint prosecution taken by Norfolk Fire Service and the HSE, Norwich School was fined £15,000 plus costs of £15,000.

The accident happened in September 2002 during a chemistry lesson in which the class was placing beakers on top of lit candles to see how long the flame took to extinguish. The victim's shirt caught fire when he either lit the candle and leant over the flame, or the beaker was removed and the flame reignited. The class teacher first tried to beat the flames with a heatproof mat, then removed the boy's shirt before using a fire extinguisher instead of a fire blanket. The boy's injuries required skin grafts and he has been left badly scarred.

The school was fined £2,500 under reg. 3(1)a of the Management Regulations 1999 (MHSWR) for having an inadequate fire risk assessment and causing danger to those in its employ. It was fined a further £2,500 under reg. 3(1)b for the same offence in relation to those not in its employ. For having inadequate refresher training in the use of fire precautions it was fined £10,000 under reg. 13(3)a of MHSWR. The school pleaded guilty to all charges.

The judge directed the jury to reach a verdict of not guilty on a fourth charge, under reg. 3(1)b, that an inadequate risk assessment had led to the accident. The school said it believed the teacher had acted well and that the way the fire had been put out had not made the injuries any worse. It added that teachers are now trained in risk assessments for experiments.

Investigating HSE inspector Alex Thomson said the HSE was "very satisfied with the outcome" and that it was keen to carry out joint prosecutions in future.

Background and comment

The school originally faced six charges. On the day that court proceedings began, they agreed to plead guilty to three charges, the prosecution dropped two charges and the court heard evidence on the one charge that the school had pled not guilty to. The class teacher was not prosecuted and the judge made it clear that no blame attached to him whatsoever.

It should be made clear that the three charges to which the school had pled guilty were whole-school matters and none was specifically related to work in science laboratories. Two of the charges on inadequate fire risk assessments were for endangering staff and pupils from things like partially obscured fire extinguishers and corridors obstructed with racking. These were technical infringements and had no bearing on the accident. The third, on the lack of fire-fighting training for any of the staff, might have contributed to the severity of the injuries, but was not proven to have done so. Nevertheless, it was taken as the more serious, reflected in the fine.

The cause of the fire was not established. The prosecution had had tests carried out on the shirt, finding that it took at least 5 seconds to ignite with the sort of candle in use. It is at least possible that the boys had been fooling around.

Our other main interest centres on the charge that the school had failed to carry out an adequate risk assessment on the experiment and that this failure contributed to the accident. Witnesses for the prosecution were the teacher, an HSE inspector and a Fire Officer. In giving evidence, the teacher came across as very sensible and thoughtful; he had identified all the risks, but the school's written risk assessment was a tick-box type of form in which the only entries were for the hazard of hot wax burning fingers and the need for eye protection. There was not a tick box for fire, probably because, the school would argue, that that was adequately covered in other documentation. His evidence did not seem to damage the defence. The HSE inspector was concerned that the school's risk assessment had not followed the *5 Steps to Risk Assessment*, but admitted that only the significant findings had to be recorded. The Fire Officer repeated many times over, at great length, the party line "If only there had been a risk assessment…". Thus the prosecution case rested on their assertion that the school's risk assessment (the tick box record, supplemented by the mental thought-processes of the teacher) had been inadequate and its supposed inadequacy had led to the accident, or had contributed to its severity. Yet under cross-examination by the Defence counsel, the prosecution case was found to be not quite so sound as they had been making out.

The case was withdrawn because, according to the Prosecution, it would not have been in the public interest to proceed with it.

In many ways it is regrettable that the trial did not continue to a verdict. The law requires work activities to be risk assessed. At the very least, up until now, a risk assessment on a laboratory experiment should have entailed thinking about the hazards, making a mental note on how the risks should be reduced, and jotting down the result in writing – even just a word of warning. Sometimes a generic risk assessment is consulted for expert advice. The HSE advise that this is not sufficient; they advocate the use of *5 Steps to Risk Assessment* for every experiment. The legal requirements will only become clear once the courts decide. In this case the HSE funked the issue (which was probably prudent because their case seemed to be flaky). Therefore any conclusions to be drawn can only be interim rather than definitive. You must ensure that every experiment is risk assessed. If the risk assessment is purely a mental process, with the results not being put down in writing, then you, the teacher, may be skating on thin ice, and your employer certainly would be. If also you rely on a generic risk assessment without annotating the text, or making brief notes in the lesson plan, that also is dodgy in today's climate. A better bet is making use of *5 Steps to Risk Assessing*. The main article in this issue says how.

Fire

When the Fire Officer was in the witness box he was asked by the Defence counsel whether he was suggesting that every chemistry teacher needed hands-on fire fighting training. He replied "If there had been a suitable and sufficient risk assessment…", from which mantra it was inferred no, but that somebody who had had it should be close by. The counsel was incredulous about this and the judge appeared to agree. It is unfortunate that the court did not indicate the scope of fire prevention training that the law requires.

Recommendations

We make the following recommendations:

- Some staff should be trained in the use of fire-fighting equipment and putting out fires.
- All Science and Technical staff should be trained in Immediate Remedial Measures; this training should be repeated sufficiently often so that the measures can be applied automatically in response to an incident.
- The Immediate Remedial Measures need to emphasise how to put out fires to clothing and hair. (A method that is sometimes effective in putting out clothing fires is STOP, DROP and ROLL.)
- The Pupil Rules need procedures for minimizing the risk of fire to pupils with loose, lightweight clothing, or long hair.
- If STOP, DROP and ROLL is put in the Immediate Safety Measures then pupils need to be trained in the procedure.

Acknowledgement

We are grateful to Dr Peter Borrows, Director of CLEAPSS, for sending us a report of the court case and letting us base this article on it. We also thank the Editor of *S&HP* for letting us reprint their account of the case.

Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)

The above Regulations were announced in Bulletin 211. We will be updating our recommendations on the storage and handling of flammables in the *Hazardous Chemicals* section of the forthcoming *SSERC SafetyNet CD.*

Even though *DSEAR* is dated 2002, the Approved Codes of Practice (ACOPs), which are necessary for its implementation, did not appear until this year. Generally these Regulations will not bite until 30th June 2006. Thus **existing** laboratories, flammable stores and activities involving flammables will, strictly speaking, not need to be assessed, recorded and, where necessary, have control measures and other forms of mitigating any potential risks made as required by *DSEAR*. However earlier assessments should have been made and control measures decided on as required by older legislation, notably by the *Management Regulations.*

Any new store or laboratory constructed after 30th June 2003 or any modification of an existing room after that date will come under the *DSEAR.*

The volumes of flammable used in school science activities are usually fairly small. Consider an organic preparation or the use of solvent in chromatography. It is common to use 40 or 50 cm^3 of flammables. In a worst case scenario, e.g. if a glass bottle were to be broken, the contents could be quickly cleared up with a spillage kit. Even if it should ignite, the fire would be small enough to be easily extinguished and it is unlikely that persons in the laboratory would be put at risk. Training in the use of fire extinguishers, blankets and the use of water, sodium carbonate or sand as appropriate should have been given previously. Normally, good laboratory ventilation will keep the vapour levels down to below the lower explosion limit. If this is the conclusion of the assessment, the laboratory will not need to be classed as a *special zone*. It will be sufficient to simply avoid the presence of naked flames or other sources of ignition alongside training in handling flammables and the use of extinguishers.

When larger quantities are handled, e.g. a full Winchester, a spillage would produce a much larger bubble or envelope of flammable vapour. Therefore sensible precautions would include:-

- the use of a bottle carrier;
- training in the technique of decanting; and
- the carrying out of this task in a fume cupboard.

For those who want to read further, a simplified digest of the Regulations is found in a booklet entitled *Fire and explosion: How safe is your workplace? A short guide to the Dangerous Substances and Explosive Atmospheres Regulations* (leaflet INDG370 from HSE Books 1 copy free or priced in packs of 5), or download from:

http://www.hse.gov.uk/pubns/indg370.pdf

Employers will need more detail and should purchase the associated Approved Codes of Practice [1]. Note that these ACOPs include the Regulations and hence there is no need to purchase these separately. (The fifth ACOP in the series (L133) is not included here as it deals with the unloading of petrol from road tankers.)

References

1. L138 *Dangerous Substances and Explosive Atmospheres Regulations* [£15.50]

   L136 *Control and mitigation measures* [£9.50]

   L135 *Storage of dangerous substances* [£9.50]

   L134 *Design of plant, equipment and workplaces* [£9.50]

Using computers safely – forthcoming guidance

When working with a computer there is no obvious, acute risk of harm unlike working with a concentrated acid or a circular saw. The risks seem innocuous – and yet users of display screen equipment (DSE) are at risk of injuries that can lead to permanent, disabling conditions which, *in extremis*, may render someone unfit for work or cause chronic pain.

Musculoskeletal pain or discomfort is a very common condition. In a recent survey [1] 85% of workplace interviewees and 65% of user questionnaire respondents reported muscular aches, pain or discomfort in the 12 months prior to the interview. Of the interviewees and respondents, 67% and 37% respectively thought that their aches and pains were related to things they did, or equipment used, at work. This could be caused by for example :-

- using a mouse for long periods (42% of users experienced pain/ discomfort).
- long duration and intensive typing.
- sitting in the same position most of the day.
- a poor chair.
- badly set-up workstation.

Injury can result from three main causes acting together :-

- Working for long periods of time without a break.
- Working too often; too frequently.
- Bad posture and technique.

It is only when all three contributory factors are present that someone is at risk. In other words it is habitual bad practice that puts someone at risk.

Because of the high incidence of computer use in the workplace and their growing use in schools, SSERC was commissioned by the New Educational Developments (NED) Division of the Scottish Executive Education Department (SEED) to produce health and safety guidance on the use of display screen equipment by children in schools.

Available in a few months time, it will appear in several formats :-

- pamphlet (Fig. 1)
- paper and web-based documents.
- training packages with PowerPoint.
- supplementary guidance for employers.

Because children *hot desk,* i.e. move around from one workstation to another from day to day or class to class, we recommend that they need to know how to set up a workstation and to put it into practice. This should be entrusted to children; the duty for seeing that it happens rests with teachers and, ultimately, their employers.

Reference

1. *Ergonomics of using a mouse or other non-keyboard input device*, Research Report 045, HSE, 2002.

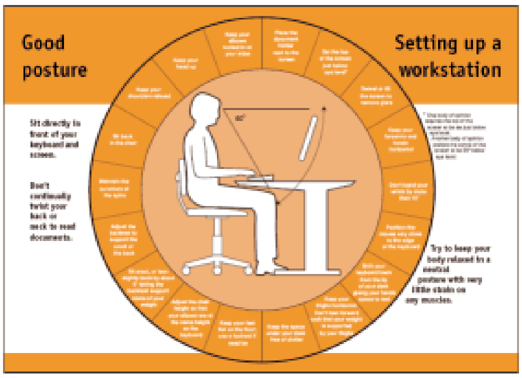


Figure 1 *From the pamphlet* Using computers safely *– guidance on setting up workstations for children and on how to prevent computer-related injuries.*

Investigating compost formation

Procedures are described on which to base a series of investigations on biodegradation and compost formation.

Compost columns, made from recycled, two-litre, plastic bottles, were a feature of a SAPS resource published as part of a series dubbed "Supermarket Science". The addition of new microbiological content to the science component of Environmental Studies at levels E and F [1] has led us to revisit these useful bits of kit. Basic instructions on making up such compost columns are to be found in a back number of "Osmosis", the SAPS newsletter [2], and on the SAPS web site [3]. The photograph in Figure 1 shows the simple components. Once so made up, these devices provide useful tools for investigative work.

Figure 1 *Basic components for a compost column cut from 2 litre drinks bottles. Also shown are some of the types of vegetable matter used to fill such a column.*

Figure 2 *A series of similar compost columns set up at intervals and monitored over time, oldest to the reader's left, youngest to the right.*

We decided to formulate, through trial and error, a basic and reliable, standard mix of vegetable waste which would degrade fairly quickly. We avoided the inclusion, at this first stage, of any non-biodegradable materials or of vegetable matter which we knew was likely to slow down the composting process (of which more, later). The recipe (a somewhat surreal concept) for this standard basic starting mix is given in Table 1.

Quantity	Material	Approximate mass (g)
1	Banana skin	55 to 60
2	Tea bags	28 to 30
6 dessert spoons	Fresh sage or parsley (damp)	6
2 portions	Lettuce (Iceberg)	100 plus 70
1	Tomato (preferably softening)	60
2 portions	Potato peelings	100 plus 70
2 portions	Carrot peelings	100 plus 70
2 portions	Cucumber skin	60 plus 20

Table 1 *Basic biodegradable compost mix. Where two separate masses are quoted this indicates that the ingredients are to be added to the column in two separate lots. Note that masses (weights) are approximate and not critical where weight loss or gain is being monitored for an individual column.*

Basic techniques

The columns photographed in Figure 2 illustrate one basic set of investigations that we've carried out in recent weeks. These involved looking at a standard composting mix over time. The major question addressed was "What changes, if any, occur in the overall mass (weight) of material as it degrades?" The usual subsidiary questions related to investigative skills naturally arose, such as "What shall we investigate and how?" or "What do we want to find out?" "How do we ensure a fair test?" etc.

A compost column was made up using such a standard mix and the column components weighed. On subsequent occasions, not only was the weight of the whole column noted but we also weighed the top, solid-filled portion separately from the bottom reservoir portion. Simple subtraction of the weights noted for the components at the outset allowed calculation of the weights of both the solids left in the column and the liquid residues that accumulated in the basal reservoir. A typical set of such results is shown in Table 2 and as a graph in Figure 3 (part only of the data).

Time (days)	Solid residue (g)	Liquid residue (g)
1	995	17
4	952	54
8	772	222
14	522	460
18	437	529
20	412	551
24	362	592

Table 2 *Note that results were usually noted every day or every other day but only a truncated set is tabulated here for illustrative purposes. Readings were taken to 0.1 g but have been rounded up to the nearest gram.*

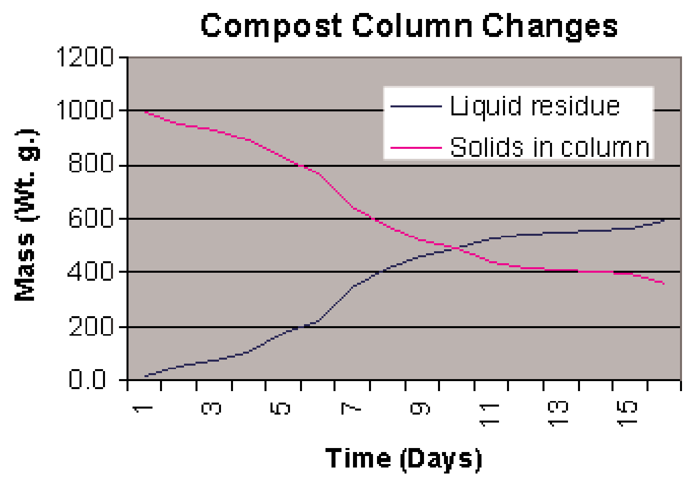


Figure 3 *Graph of the data from Table 2 over 1-17 days.*

Interpretation

At first sight the interpretation of these results seems quite straightforward. As the solid material in the top of the column rots down, its mass decreases whilst the mass of liquid residue draining into the bottom reservoir increases. There is, however, an obvious disparity when one looks at the total mass over time. On day one, the total mass of solid and liquid residues was 1,012 g. By day 24 that total has fallen to 954 g. What happened to the other 58 g. of material present at the outset? Ask the pupils what they think. Was there water in the materials at the beginning? Has it evaporated? What other explanations can they offer? What causes the transformation of the material? Could it be that there are living organisms amongst the dead matter in the column? How might that explain the weight loss?

Taking things further

Much of the weight loss may be attributable to catabolic activity breaking down the vegetable matter and to the activities of micro-organisms in the column. These microbes are utilising the materials as substrates for respiration. If respiring organisms are indeed present, then how might we investigate this? Could some of the change in mass be attributed to evolution of carbon dioxide? How might we test that idea? Is heat generated as a by-product of respiration? Could we use a data logger such as an I-button [4] to find out? What happens if we thermally insulate a compost column?

This basic technique is potentially applicable to investigative work right through secondary - even up to, and beyond, Advanced Higher levels. Ideas we have explored have included systematic changes in the composition of the compost ingredient mix. For example, gardeners are often advised not to compost grass clippings (which are rich in nitrogen) without admixing them with other, coarser, types of vegetable matter (rich in carbon). Similarly, where kitchen waste such as peelings from fruit and vegetables are utilised it is advised that we avoid the use of peelings from citrus fruits (because they lower the pH). Again, we used potato peelings as part of our basic mix but this also is usually frowned on. Is such advice well founded? How might we find out?

Microbiological possibilities

Apart from teacher demonstrations, microbiological investigations on this topic are probably best restricted to post-16 work (Level 3). We've only just begun to look at these possibilities as starters for investigations at Advanced Higher level but they look promising. For example, when we inoculated nutrient agar plates with a small volume of the liquid residue (3 drops per plate) the subsequent growth of organisms swamped the plate overnight. We've since used dilutions of the residue in sterile distilled (de-ionised) water. Growing up such dilute inocula on both nutrient agar and malt extract agar have yielded some interesting (and more manage-able) results. Only one step – sampling the undiluted liquid residue – lies outwith the scope of the standard code of practice (see the summary of risk assessment results appended to this article).

These ideas look sufficiently promising for us to trial them further. We will then consider writing them up as one of the SAPS series of starters for investigations.

(continued over/ **References & Risk Assessment**)

References

1. Environmental Studies 5-14, Guide for Teachers and Managers, Science, Attainment Outcome : Living Things and the Processes of Life – specifically attain-ment targets at Level E "The harmful and beneficial roles of microorganisms". Note that there are a number of other relevant curricular references in Environmental Studies and elsewhere on recycling, landfill etc.
2. "Osmosis", issue number 2, SAPS, Student Sheet revised 1995. (Note that SAPS/SSERC have a simpler technique which uses only two bottles).
3. The reference in 2. can also be downloaded from the SAPS website at: http://www-saps.plantsci.cam.ac.uk/worksheets/worksheets/supsci2.htm
4. "Right-on the i-button", Science and Technology Equipment News Number 24, SSERC, Winter/Spring 2002. An interactive version is posted on the ISE 5-14 website: http://www.ise5-14.org.uk/prim3/New_Guidelines/Newsletters/24/body.htm

An extended version of this article will be posted on the SSERC web site www.sserc.org.uk

Risk Assessment for SSERC (based on HSE *5 steps to risk assessment*)

Assessment

Date undertaken :- 29th November 2004

Assessor - signed :- ________________

Activity :- Investigating compost

Assessment Review Date :- __________

Description of activity

Investigating compost columns.

See article in Biology Notes SSERC Bulletin 213 Winter 2004/05.

For more detail on constructing columns from recycled plastic ware, and suggested safety points thereon, see "Making a compost column" originally published by SAPS in Osmosis no. 2 as part of the SAPS "Supermarket Science" series. Since revised (October 1995) and available from the SAPS web site.

Step 1	Step 2	Step 3
List Significant hazards here:	**List groups of people who are at risk from the significant hazards identified:**	**List existing controls or where the information may be found. List risks not adequately controlled and action needed:**
Cuts and minor puncture wounds from materials or tools in constructing the compost columns.	Technicians (or students) in constructing the columns.	See the SAPS instruction sheets.
Infection from micro-organisms growing in column.	Students and teachers using columns. Technicians disposing of columns particularly liquid residues. Janitors/cleaners and others who use the premises.	Keep any cuts or broken skin covered. After handling compost column or vegetable waste wash hands well with soap and hot water. Use only vegetable matter and avoid the use of any animal waste. Once columns are filled keep intact avoiding spillages (maintain containment). Particular care to be taken to avoid spillages if liquid residues sampled or transferred (else aerosol formation possible).
Infections if organisms are cultured.	As above.	Aseptic technique to be used when culturing or transferring micro-organisms (see Code of Practice and SSERC CD ROM on microbiology or HSDU Techniques Cards).
Allergenic reaction to fungal spores.	As above.	See entry on maintaining containment. Subjects with respiratory or immune-deficiency problems to avoid columns when opened or being moved.

Additional comments

The infection risk from the raw plant matter is not significantly different from that met with in everyday life in routine food preparation. If the liquid residue is sampled, however, then the number and range of organisms present will have increased considerably. This then offers greater risk than that met with simply handling the plant waste. Once the sample has been serially diluted, the population density of the organisms obviously will fall and normal aseptic techniques will again adequately control the risks. The chances of any potentially serious infection will be raised if the columns are not kept aerobic so they need to be kept reasonably well ventilated.