Loughborough University

Department of Physics

SAFETY HANDBOOK

Original Version

R.T. Giles

Last update

K.-U. Neumann, September 2010

Contents

1. Safety Induction of New Staff and Research Students

All new staff must be directed to see the Safety Officer and all supervisors should ensure that new research students and research associates also see the Safety Officer. All research workers should have a copy of this handbook, and all technical, administrative and secretarial staff should have ready access to a copy.

2. Who is Who?

Safety Officer	Dr K.-U. Neumann
Laser Safety Officer	Dr. M. Gaifullin
Radiation Protection Supervisor	Mr. B. Dennis
COSHH Coordinator	Mr P. Sutton
Assessor for Manual Handling of Loads	Mr B Dennis
Cryogenics Technician	Mr B Dennis
Assessor for Display Screen Equipment	Mr M Stenlake
Chemical Inventory Maintenance	Mr B K Chavda
Maintenance of Safety Notices, Safety Library, First Aid Kits and Supply of Safety Forms	Mr. B. Dennis

Fire Evacuation Marshals :

Area 1	**Physics Workshop (W0.11)** **Undercroft** **Opto-Electronics**	**Mr. B. Dennis**
Area 2	**W1.41, W1.44** **male toilet** **W1.44 - W1.59**	**Dr. K.-U. Neumann**
Area 3	**W2.9 - W2.19**	**Mrs. McKenzie**
Area 4	**W2.21 - W2.32** **male and female toilets**	**Mr. M Pancholi,** **Mr. R. Pancholi**

Trained First-Aiders	
Mr Bryan Dennis	Mechanical Workshop
Mr Phil Sutton	Mechanical Workshop
Mr Ramesh Pancholi	W2.31
Mr Raj Pancholi	W2.31

Membership of the Departmental Safety Committee

Dr K.-U. Neumann Chairman, Safety Officer

Mr B. Dennis Assessor for Manual Handling of Loads, Workshop Superintendent

Mr B. Dennis Radiation Protection Supervisor

Dr. M. Gaifullin Laser Safety Officer

Mr P. Sutton COSHH Co-ordinator

Mr M. Stenlake Assessor for Display Screen Equipment

Mr M. Pancholi, Mr R. Pancholi Electrical Safety Officers

3. Emergency Procedures and First Aid

3.1. Fires and Evacuation

3.1.1. What to do if you find a fire

Fire alarm buttons, water hoses and evacuation procedure notices are located in the stairwells. Red fire extinguishers containing water are located on every corridor and black carbon dioxide cylinders (particularly suited to electrical fires) are located in the teaching laboratories and elsewhere. Red emergency buttons for cutting off the electricity supply are situated near a light switch (near the exit) in most laboratories and should be used in the event of electrical fires.

In the event of a fire that cannot be extinguished immediately you should:

1) Sound the fire alarm to evacuate the building. The alarm system does **not** automatically call the fire brigade.

2) Dial 888 (this emergency number is written on every phone), to inform the University switchboard operator of the exact nature and location of the fire. The operator will then call the County Fire Service.

3) Close the door of the room containing the fire and go to the assembly point.

4) Brief the Fire Service when they arrive.

3.1.2. What to do when you hear the alarm

When the alarm is given (continuous loud bell) you should leave the building by the nearest evacuation route (see notice in Department entrance foyer) and proceed to the assembly point on the path outside the main entrance to the Department. Close doors behind you and do not run.

Nominated marshals will ensure that their respective areas are clear of people and report to the Head of Department or the Safety Officer or most senior member of academic staff at the assembly point.

N.B. The fire alarm system is tested on Mondays at 12 noon. At that time it can be ignored if only brief bursts are heard.

3.1.3. Evacuation of people in Wheelchairs

Any person in a wheelchair or anyone who for whatever reason, is unable to follow the normal evacuation procedures, should make himself/herself known to the departmental safety officer, who will inform them as to the appropriate procedures in the case of an alarm. For people in a wheelchair evacuation from the first floor does not present a problem. For evacuation from the second floor the person should **not** use a lift, but move to the location near to the stairs at the main entrance to the physics department. This area is located in between the fire doors. If immediate danger exists the person has to be evacuated via the stairs to the assembly point outside the department. Ensure that the Fire Service is informed of the location of the person in the wheelchair.

Any person in a wheelchair wishing to work out of normal working hours within the department will only be allowed to do so if adequate arrangements are in place for ease of evacuation.

3.2. Toxic Release or Spillage

In the event of a serious incident which cannot be safely contained within one room, the fire alarm should be sounded and the building evacuated as

for a major fire; this includes dialling 888. In the event of a more minor incident the immediate area should be evacuated and the Head of Department, Safety Officer and University Health and Safety Officer should be informed.

N.B. Never wash spilled chemicals into an outdoor drain.

3.3. Bomb Alerts

Evacuate the building as for a fire and dial 888.

3.4. First Aid

As well as being listed in section 2, lists of trained first-aiders are posted in two places: outside the first year teaching laboratory and at the main entrance to the building.

In the absence of a first-aider the University Medical Centre should be telephoned (2061) or, if the situation warrants, an ambulance should be called (preferably by dialling 888 but otherwise 9999). In the event of injury by chemicals the appropriate COSHH assessment (held in a file on the wall in the laboratory) will give information about the chemicals being used and the appropriate first aid treatment.

In cases of electric shock it will be important to turn off the electricity supply. Red emergency cut-out buttons are provided for this purpose near a light switch in most laboratories.

4. Reporting of Accidents, Dangerous Occurrences and Occupational Ill-Health

Prompt reporting of all incidents is crucial. For serious incidents it will be appropriate to speak immediately to the Safety Officer and/or Head of Department.

All accidents requiring first aid treatment should be recorded in two places

i) On an LUT accident report form (available in the General Office) which should be forwarded immediately to the Department Safety Officer, who will then forward it to the University Heath and Safety Officer.

ii) In one of the two DHSS Accident Books (form B1510) in the Department. One is in the General Office and the other is in the Mechanical Workshop.

The report form should also be used for:

i) Cases where it appears that work has had an adverse effect on health e.g. skin or respiratory irritation.

ii) Cases of electric shock and other potentially hazardous incidents which could have caused a serious accident (or fire).

5. Your Responsibilities

Health and Safety Executives can and have taken legal proceedings against all classes of employers and employees for breaches of health and safety legislation.

5.1. All Individuals

All individuals are responsible for:

‡ Ensuring that they are adequately informed about the aspects of safety relevant to the work that they are doing. If in doubt, consult the Safety Officer.

‡ Showing due regard to the safety of themselves and of others.

‡ Complying with the rules given in this booklet.

‡ Acting to make safe or reporting to the Safety Officer any apparent hazard within the Department.

‡ Making themselves aware of what to do in emergencies and of the locations of fire alarms, fire extinguishers, and staff trained in first aid.

5.2. Head of Department

The Head of Department has the executive responsibility for implementing University Health and Safety Policy and for ensuring compliance with the law. The various departmental safety officials merely act as advisers to the Head of Department.

5.3. Members of Academic Staff

No laboratory work can be carried out in the Department except under the supervision of an individual member of academic staff who is responsible for ensuring that the supervisee is adequately trained in the relevant aspects of safety, and for ensuring that the work is carried out safely.

5.4. Workshop Superintendent

The Workshop Superintendent is responsible for ensuring that all technicians receive adequate training for the work that they do and for ensuring that safe working practice is observed.

5.5. Radiation Protection Supervisor

The Radiation Protection Supervisor is responsible for supervising safety matters concerned with ionising radiation, as laid down in the University's "Local Rules for the Protection of Persons Exposed to Ionising Radiation".

5.6. Laser Safety Officer

The Laser Safety Officer acts as a focal point for the dissemination of laser safety information in the Department and acts as adviser to the Head of Department on laser safety matters. He/she is also responsible for regular audits of laser safety within the Department, and represents the Department on the University's "Non-Ionising Radiation Technical Group".

5.7. Health and Safety Officer

The role of the Health and Safety Officer is to act as a focal point and adviser to the Head of Department on general safety matters (excluding lasers and ionising radiation). He/she is also responsible for organising regular safety audits (excluding lasers and ionising radiation) and for ensuring that new members of the Department are fully aware of University and Departmental safety policy.

5.8. COSHH Coordinator

The role of the COSHH co-ordinator is to keep a watchful eye on chemical safety matters in the Department. He/she should inspect all COSHH forms on receipt to check that all reasonable safety precautions are being taken and to check that no really hazardous work is being undertaken in the Department. He/she should undertake Departmental audits of chemical safety, and act as advisor on chemical safety to the Director of School.

5.9. Assessor for Manual Handling of Loads

The Assessor for Manual Handling of Loads is responsible for conducting load handling assessments in accordance with University policy.

5.10. Assessor for Display Screen Equipment

The Assessor for Display Screen Equipment is responsible for conducting workstation assessments in accordance with University policy.

5.11. Personal Safety

Any person working within the Department of Physics has to ensure that at all times his/her activities are, to the best of their knowledge, safe and adhere to existing safety regulations.

Some points of consideration include:

Tiredness increases the probability of accidents and wrong reactions. Regular breaks and recovery periods should be planned into the work schedule.

Straining of the Voice in lectures/talks etc. The voice is a valuable instrument, which should not be strained by excessive used. Precautions have to be taken to avoid damage during lectures/talks etc.

Adequate lighting should be ensured for all types of work.

Smoking - The University operates a No Smoking Policy except in designated areas.

6. The Departmental Safety Committee

The Safety Officer, Laser Safety Officer, Radiation Protection Supervisor and COSHH Co-ordinator, together with the Director of School, are responsible for taking the day to day decisions about safety matters and should report all major decisions to the Departmental Safety Committee for comment. It is the responsibility of the committee to ensure that they are satisfied with all aspects of safety management within the Department. Minutes of the committee meetings will be forwarded to the Head of Department, and the committee can require a meeting with the Head of Department if it is not satisfied with the actions taken by the Department's safety officials.

Committee members (see section 2) are chosen to represent all groups within the Department and it is, in particular, their duty to be vigilant about safety matters affecting the groups that they represent.

7. Where to find safety information

This booklet only provides general guidance and basic information. It does not obviate the need to seek specialist advice or to read further safety literature. A range of safety literature is held in the **Department Safety Library** in W2.24: it includes information on specific chemical hazards, first aid, laser safety, University Health and Safety Policy and other topics. Further literature is available in the University Health and Safety Office. Advice can always be sought from any of the Department's safety officials or from any member of academic staff.

8. Rules for supervising undergraduates

1. No undergraduate may ever work alone when undertaking laboratory work.

2. Undergraduates must obtain the permission of a member of academic staff if they wish to undertake laboratory work outside of the undergraduate teaching laboratories or outside of the specified hours for a laboratory class which they are scheduled to attend.

3. A member of academic staff, who gives permission for an undergraduate to undertake laboratory work, consents to supervise that work and is

responsible for ensuring that the work is carried out safely. This also applies to supervisors of laboratory sessions and to project supervisors.

4. Project work and work which does not involve standard experiments in any of the laboratories has to be risk assessed before a student is allowed to start. The risk assessment has to be discussed and agreed with the supervisor and it needs to be documented in the student's log book. The supervisor has to sign off the risk assessment. As the work progresses the risk assessment has to be updated if any aspect of the work requires it.

5. In the case of scheduled laboratory classes, the responsible member of academic staff must either be present in the main laboratory or ensure that a technician or demonstrator is present in his/her place. Even when out of the laboratory the main responsibility for the safe running of the laboratory rests with the member of academic staff.

6. Project supervisors must nominate a member of staff to act in their place if they are absent for more than a couple of hours.

7. No undergraduate may work in the Department outside of normal hours (9.00 am - 5.30 pm, Monday to Friday) unless the member of academic staff who is supervising them is present in the Department.

8. Project supervisors must instruct their students in safe working practice. Every project student will have access to a copy of this booklet, via the web.

9. Rules for supervising Postgraduates and Research Associates

1. Supervisors of postgraduates and research associates are responsible for ensuring that the supervisee is properly trained in all relevant aspects of safety and for ensuring that safe working practice is observed at all times.

2. Every postgraduate and research associate must have access to a copy of this booklet.

3. Supervisors have a legal responsibility to ensure that they give their supervisees a level of supervision, which is appropriate to the hazards involved, and to the experience and abilities of the supervisee. For any remotely hazardous work a weekly meeting between supervisor and supervisee should be considered a minimum level of contact.

4. Supervisors who are absent from the Department for any significant length of time must nominate a member of academic staff to act in their place. Except where no hazard exists this must always be done for absences exceeding a week.

10. Rules for Working Out of Hours

"Normal hours" are taken as 8.00 am to 6.00 p.m. Monday to Friday during periods when the University is open. Anyone working in the Department outside these hours of during a weekend or public holiday must, on entering the Department, make an **entry** in the **Late Working Register**, which is situated in the main entrance foyer. Where the activity involves potentially hazardous work the Security Office should be notified by telephone. On leaving the building, the time of departure should be recorded in the Late Working Register.

N.B. Do not use the lift for the transport of people after 5pm or at weekends.

11. Rules for Working Alone

Where there is virtually no hazard involved in the activity (e.g. office work, or use of commercial electrical equipment where there is no danger from high voltages or moving parts) the work may be carried out alone. In all other cases a second person must be within calling distance whenever the hazard is present. Examples of particularly hazardous work, which should never be carried out alone, are:

‡ Work with exposed electrical equipment at dangerous voltages.

‡ Use of dangerous chemicals.

‡ Use of machine tools and equipment capable of inflicting serious injury.

12. Rules for Operating Unattended Equipment

The most destructive accidents to apparatus and buildings often occur through unattended operation of equipment. All equipment should be turned off when not in use and unattended operation of equipment should be avoided where this reduces the level of safety. No system should rely for its safety on the maintenance of a supply of cooling water or of mains electricity. Where any equipment is left on out of hours it must carry the official "Yellow Card" notice signed by a member of staff. The notice must contain detailed switching off procedures together with the telephone number of a responsible person with whom contact can be made in the event of an accident. Further, if any special hazards are involved these must be recorded for the benefit of the night security patrol. The patrol will switch off any apparatus, which has been left on without such a notice attached to it. The Yellow Card notices are available from the "Safety Forms" drawer in the General Office.

13. Working with Electricity

13.1. What is a dangerous voltage?

A "dangerous voltage" is usually defined as over 55 volts. However, where a source is such that it is impossible for it to supply more than one milliamp continuously it may be regarded as safe whatever the voltage (although it should be noted that a one milliamp supply can cause uncontrollable muscular movements and should not be exposed in conditions where there are dangers such as rotating machinery). Furthermore, where persons are connected to apparatus deliberately or where contact with earth is extremely good, voltages very much lower than 55 volts should be regarded as dangerous.

13.2. Dangerous Currents

With high current sources (e.g. batteries) the danger arises from a possible short circuit. Wherever possible they should be protected by fuses or circuit breakers as close as possible to the source. Rings must never be worn when working with unprotected high current sources; even quite small nickel cadmium cells have been known to produce enough current to sever a finger when short circuited by a gold ring.

13.3. Working with Dangerous Voltages

The full code of practice is given in Appendix X of the University's Statement on Health and Safety Policy, http://www.lboro.ac.uk/admin/hse/policies/index.html to which you should refer if working with dangerous voltages. For further information see HS&E: Electricity at work. The main points to note are:

‡ Avoid working with exposed dangerous voltages if at all practicable. Students should consult their supervisors before undertaking such work.

‡ Never leave dangerous voltages exposed to act as a hazard to others.

‡ Use an earth leakage trip (set to 30 mA or less) if at all practicable, or carry out the work in the Electronics Workshop which is protected by an RCD. However, never place absolute reliance on an RCD.

‡ Never carry out such work alone and make sure that a First Aider fully trained in resuscitation techniques is available.

‡ Get the advice of the technicians in the Electronics Workshop as to the safest way to carry out the work.

13.4. Wiring

Under no circumstances should the yellow-green colour code be used for anything other than safety earth wire. All wires which form part of an earth

safety system (not merely connected to earth) should be colour coded green-yellow. Earth wires should never be disconnected.

Anyone with any doubts whatever about wiring, should consult the technicians in the Electronics Workshop.

14. Working with Ionising Radiation

α , β and γ radiation from radioactive sources, X-rays, neutrons and energetic electrons all have the capacity to ionise atoms and are thus termed "ionising radiation". Any apparatus in which charged particles are accelerated in a vacuum vessel through a potential difference of more than 5 kV must be regarded as a potential generator of X-rays.

All work with ionising radiation must be carried out under the supervision of the Departmental Radiation Protection Supervisor, and in accordance with the University's "Local Rules for the Protection of Persons Exposed to Ionising Radiation" http://www.lboro.ac.uk/admin/hse/policies/index.html. See also work with ionising radiation.

The principal sources of ionising radiation associated with the Physics Department are:

‡ X-ray diffraction equipment.

‡ Neutron scattering work carried out at facilities outside Loughborough.

‡ Small X-ray set in the 2nd year teaching laboratory.

‡ High voltage equipment used for surface analysis.

‡ Synchrotron radiation work carried out at facilities outside Loughborough.

‡ Radioactive substances.

Any woman who knows, or suspects, she is pregnant should consult the radio protection officer before commencing with any work involving ionising radiation.

14.1. X-Ray Diffraction Equipment

Anyone using an X-ray set must first contact the Departmental Radiation Protection Supervisor.

The small X-ray set in the 2nd year teaching laboratory can be used without consulting the Radiation Protection Supervisor, but the responsible member of academic staff must give students proper instruction. If correctly set up, the dose outside the enclosure is entirely negligible and

there is an interlock which turns off the X-rays when the cover is lifted. All users of this equipment should use the GM tube to check that no leakage can be detected and that the cover interlock is functioning properly.

14.2. Neutron Scattering and Synchrotron Radiation Work

Anyone going to a neutron scattering facility from Loughborough for the first time must contact the Departmental Radiation Protection Supervisor. Anyone who wishes to bring neutron-activated samples into the Department must seek the permission of the Radiation Protection Supervisor.

Users of synchrotron radiation facilities need not contact the Radiation Protection Supervisor, but may if they wish ask him/her for a dose-monitoring badge.

14.3. High Voltage Equipment

Equipment in which charged particles are accelerated through potential differences greater than 5 kV (in one or more steps) should be checked for X-ray leakage every six months. New or recently made equipment of this type should be checked for X-ray leakage before use. All checks should be performed by the Departmental Radiation Protection Supervisor.

14.4. Radioactive Substances (including neutron activated samples)

14.4.1. Radioactive Material

Anyone wishing to bring any radioactive material into the Department (including uranium and thorium compounds) must first inform the Radiation Protection Supervisor.

Anyone wishing to use a radioactive source for the first time must first consult the Radiation Protection Supervisor.

15. Working with Cryogenic Fluids (Nitrogen and Helium)

The hazards of liquid nitrogen and liquid helium are:

‡ the intense cold creating a danger to skin and also to eyes (from spitting)

‡ asphyxiation due to displacement of air

‡ rapid build-up of pressure due to boiling (particularly for liquid He which has a very small latent heat)

‡ condensation of liquid oxygen from the air giving rise to a combustion hazard (especially for liquid helium)

The Cryogenics Technician must first train anyone intending to use liquid helium. Anyone intending to use liquid nitrogen should also make sure they are properly trained, preferably by the Cryogenics Technician. In any event the following rules must be adhered to by anyone handling cryogenic fluids:

1. Thick, non-absorbing, loose fitting gloves should be worn - preferably specially designed cryogenic gloves.

2. Safety spectacles must be worn.

3. The arms and upper body must be covered.

4. The area should be well ventilated, - open a window.

16. Working with Computers and Other Display Screen Equipment

16.1. The Hazard

The hazard here is the physical strain on the human body from spending long periods working at a keyboard. Back problems, repetitive strain injury, varicose veins, eye strain etc. can all result from long periods of keyboard work, particularly if insufficient attention is paid to the sitting position. Adjustable seats, footrests, keyboard position etc. should all be adjusted for the individual using them (just as you don't drive a car without first adjusting the seat), and frequent short breaks should be taken from intensive keyboard work. Anyone doing regular keyboard work for hours at a time should consult the Departmental Assessor for Display Screen Equipment for advice as to how to reduce the risks of injury.

16.2. Standards Required for Workstations

Any new workstation (e.g. a desk with a computer on it) must comply with the following rules. Any old workstation, which is used for long periods of intensive work, should also meet these standards.

1. The chair must have a five-star base with back support for the lumbar region.

2. Footstools must be provided for people who can't put their feet flat on the floor after properly adjusting the chair.

17. Working with Machine Tools in the Mechanical Workshop

The following rules must be observed:

i) Permission must be obtained from the Workshop Supervisor before any of the machines may be used.

ii) No machine may be used unless there are at least two people present, one of whom is an experienced technician.

iii) Machine operators must wear safety spectacles and stout footwear (preferably safety shoes and definitely not sandals).

iv) Guards must be used where fitted.

v) Long hair must be tied back. Machine operators should not wear any loose clothing, which could become entangled in the machine.

vi) Good housekeeping practices must be observed, and in particular, the floor should not be left in a dirty or slippery condition.

vii) Grinding wheels may only be dressed or adjusted by those holding an appropriate training certificate.

viii) If in any doubt about safety, the Workshop Supervisor should be consulted.

18. Working with Substances Hazardous to Health

The Control of Substances Hazardous to Health (COSHH) Regulations 1988 and the Associated Codes of Practice require that a written risk assessment be made before taking any action (storage, use, disposal), involving any but completely insignificant risk, with substances hazardous to health (excluding radioactive hazards - see section 14). Failure to do this can result in criminal prosecution of those guilty of neglect.

Where small quantities of chemicals are properly stored (see section 18.3) in accordance with manufacturers instructions, it will not normally be necessary to make such a "COSHH assessment". However, COSHH assessments must be made before disposing of or using (reacting, heating etc) hazardous substances. Under the COSHH Regulations and Codes of Practice, the person working with hazardous substances and his/her superiors must be able to prove their compliance with the regulations and the only way to do this is by making written risk assessments, for which forms are available.

The COSHH forms relating to the work in any laboratory are stored in a file on the wall near the door of the laboratory and available for inspection by anyone concerned (although permission to enter the laboratory may be necessary).

18.1. Making a COSHH Assessment

18.1.1. What goes into a COSHH assessment?

A COSHH assessment must be in writing, and if the advice given here is followed, it can be quite brief. The essential elements of a COSHH assessment are:

1) Recognition and evaluation of the health risks which arise from the use of hazardous substances (and any additional hazardous substances which may be produced by chemical reaction).

2) A description of the effective control measures, which will be used to protect all, those at risk (including such people as cleaners, visitors, and members of emergency services where relevant).

18.1.2. Obtaining Information and Advice

Anyone involved in making COSHH assessments will need to make use of the Departmental Safety Library (see section 7). The University's guidelines on making COSHH assessments are given in Appendix XVI of the University's Statement of Health and Safety Policy. http://www.lboro.ac.uk/admin/hse/policies/index.html. The Chemistry Department's safety booklet entitled "Safety in the Laboratory" is a valuable source of general information about chemical safety. The manufacturer's catalogues and hazard data sheets provide information about specific chemical compounds. In case of any doubt, advice should be sought from the COSHH co-ordinator.

18.1.3. When to use a Fume Cupboard or Special Containment Facility

Looking up the hazards associated with a substance is a simple matter, but an assessment of "risk" also includes the more difficult business of estimating the exposure potential which depends on the quantity, nature (e.g. powder or solid lump) and containment of the substances involved. Fortunately the Royal Society of Chemistry have devised a simple way of placing risks on a relative scale so that one can determine, for example, whether a process may be safe to carry out on an open bench or whether a fume cupboard should be used. This risk assessment method is described briefly in Appendix A and more fully in the booklet "COSHH in Laboratories" which is in the Departmental Safety Library.

18.1.4. COSHH Assessment Forms and the Use of Laboratory Notebooks

The University Health and Safety Office have devised a form for making COSHH assessments and these can be found in the "Safety Forms"

drawer in the Physics Department General Office. To reduce the amount of form filling associated with a research project, the University Health and Safety Office envisage that, before the project starts, sufficient forms should be filled in to cover all the classes of compounds which may be encountered. The day to day details relating to chemical safety measures can be left to a laboratory notebook which itself may refer to the COSHH forms associated with the project and to previous safety notes within the same, or another, notebook. The Chemistry Department's booklet "Safety in the Laboratory" provides detailed recommendations as to how to do this. What is important, from a legal point of view, is that one can demonstrate that a suitable risk assessment was made and suitable control measures taken for every piece of work involving hazardous substances.

Guidance on how to fill in the COSHH forms is given in the Chemistry Department's booklet "Safety in the Laboratory" and in Appendix XVI of the Statement of University Health and Safety Policy. A valuable shortcut in filling in the form is that it is permissible, on the form, to refer to things you have read (e.g. the appropriate hazard data sheet) for details (e.g. first aid treatment). What is necessary is to provide written evidence that you have made yourself aware of the risks involved and are taking all appropriate precautions.

When complete, the form should be signed by the person in charge (normally a member of academic staff and never a student). **One copy** should be forwarded to the **COSHH Co-ordinator**, **one copy** should be placed in the **COSHH file** in the room in which the work will be undertaken and the **person doing the work for their reference and records should retain the third copy**.

Provided the procedure involves very little risk (recommended containment regimes 1 and 2 on the Royal Society of Chemistry scale) it can then be carried out, following the rules given in section 18.2. In the case of higher risk work requiring special containment or air monitoring, the COSHH Co-ordinator and Safety Officer must be consulted.

18.2. Following a procedure for which a COSHH assessment has been made

18.2.1. Before starting work

1) Check that you fully understand all aspects of the COSHH assessment: the hazards involved, the precautions required, first aid treatment and what to do if things go wrong (e.g. spillage). If in any doubt, check the assessment for yourself or seek expert advice.

2) Check the location and availability of all necessary safety systems and information, i.e. first aid equipment, fire-fighting equipment, hazard data sheets etc.

3) Make sure that you are properly clothed. Safety spectacles and lab coats will normally be required. Proper shoes should be worn (never sandals) and long hair should be tied back. Gloves will also often be required.

4) Check that a second person will remain within calling distance while the work is being carried out.

18.2.2. Rules to be observed while working with chemicals

1) A second person must always be within calling distance.

2) Eating, drinking and smoking are prohibited in areas where chemicals are being used.

3) Bench tops should be kept clean and tidy, and gangways kept free from obstruction.

4) Pipetting by mouth is prohibited.

5) Gas cylinders should be adequately secured (tied) and turned off when not in use.

6) Gas burners should not be left burning unattended.

7) Never lift a Winchester by the neck - transport it in a suitable carrier.

8) Chemicals should be returned to cupboards as soon as practicable.

9) If in doubt, stop what you are doing and seek advice.

18.3. Storage of Chemicals

Manufacturers make recommendations as to how chemicals should be stored and these should be followed. Furthermore the following simple rules should be complied with:

1) Chemicals should always be stored in cabinets and specially designed bins or racks, - never on open shelves, on benches or on the floor.

2) All chemical containers should be properly labelled.

3) Large containers of liquids (e.g. Winchesters) should be stored near floor level.

4) Oxidising agents should not be stored in the same cupboard as organic compounds. A further list of chemicals, which should be

stored separately, is given in Appendix B. Refer also to manufacturer's information.

5) Quantities of flammable liquids (solvents) greater than 500 ml must be stored in fire resisting cupboards or bins.

6) No room may contain more than 50 litres of flammable liquids (solvents).

7) Scheduled poisons must be stored in a locked, labelled cupboard, which is used for storing poisons and nothing else.

18.4. Spillages

18.4.1. Spillages of Mercury

Spillages of mercury are very dangerous since poisoning by mercury vapour is slow, insidious, cumulative, and often unrecognised before irreversible damage is done. A spillage should be treated as follows. Contain the spillage to as small an area as possible, scoop up as much as possible into a glass, plastic, or iron container, and collect any droplets by means of a fine capillary connected to a filter-flask and water-pump. Decontaminate the area affected by tiny droplets by pasting it with a slurry of slaked lime ($Ca(OH)_2$) and flowers of sulphur mixed with a little water. (Take Care: this mixture is somewhat caustic). The slurry should be allowed to dry and after 24 hours it should be removed with clean water and kept for correct disposal. If it is suspected that a laboratory is contaminated with mercury vapour then the Departmental COSHH Co-ordinator should be consulted for the appropriate monitoring to be carried out.

18.4.2. General Treatment of Spillages

The treatment of spillages is something, which should be foreseen as part of the COSHH assessment. Recommendations on how to deal with spillages are given in the hazard data sheets, manufacturer's information and on the BDH wall chart "Dealing with Spillages of Hazardous Chemicals". However the following simple rules generally apply:

1) Priority must be given to treatment of people affected by spillage with regard to washing off the chemical, removal of contaminated clothing and any necessary first aid. The nearest emergency shower is outside room S02.11 in IPTME. The nearest normal showers are at the EHB squash courts.

2) In the event of a major spillage producing toxic, irritant or flammable vapours the laboratory should be evacuated and, in an extreme case, the fire alarm should be pressed.

3) Strong acid spills should be neutralised with washing soda or sodium bicarbonate.

4) Strong alkali spills should be neutralised with citric acid.

5) The spillage should be mopped up with absorbent material.

6) Never wash spilled chemicals down a drain, particularly an outdoor drain. Take all practicable steps to prevent chemicals entering an outdoor drain.

18.5. Use of Fume Cupboards

There are three principal uses to which fume cupboards are put:

1) Removal of toxic fumes in the course of experimental procedures.

2) Confinement of potentially dangerous reactions.

3) Storage of toxic and corrosive substances which may emit harmful vapours.

The use for storage is not compatible with the use for potentially dangerous reactions and no experimental work should ever be carried out in a fume cupboard in which dangerous chemicals are stored, because of the danger of escalation of a minor accident into a major one. Before using a fume cupboard for experimental work, therefore, all bottles and apparatus not being used for the moment should be removed to a safe storage area. Make sure that the sash can be closed quickly without disturbing the apparatus. Further, the rate of release of any toxic gases must not be such as to cause the effluent from the fume cupboard to escape to contaminate the laboratory. If it is suspected that this is the case, the Departmental COSHH Co-ordinator will be able to inform you as to the rate of flow of air through the cupboard and its suitability for adequate containment of the toxic materials concerned.

If equipment has to be left in a fume cupboard a proper notice must be put up reserving the fume cupboard, indicating any hazard involved and carrying the signature of the person concerned. When the experimental work is completed, the cupboard should be cleaned out and any unwanted products disposed of.

18.6. Use of Ovens, Furnaces and other Sample Heating Equipment (e.g. the Differential Scanning Calorimeter)

The principal danger here is from fumes that may be given off as the equipment is heated. The fumes may arise from the experimenter's own sample or from any contamination remaining from previous use of the oven. The following rules must be followed when using such equipment:

1) Make a written COSHH assessment (as for any process involving chemicals) and give consideration to the possibility that the oven overheats.

2) Check there is nothing else which will also be heated and create a hazard (dirt etc, from previous oven use).

3) Never leave the oven unattended while it is heating up unless you are absolutely certain that no danger exists.

4) If leaving the oven unattended it must be clearly labelled giving:

‡ Your name and how to contact you.

‡ The contents of the oven.

5) Don't think twice about switching off an oven, which is in use but unattended and unlabelled.

6) Leave a window open as a precaution.

7) Don't put mercury thermometers into ovens.

18.7. Disposal of Chemical Waste

The law in this area is very stringent and **all** individuals associated with illegal disposal of chemicals are liable to criminal prosecution. Producers of chemical waste have to accept that the waste disposal method may take up more of their time than the process, which produced the waste in the first place. Production of chemical waste should be minimised and consideration of the disposal method should form part of the COSHH assessment.

Chemical waste should **never** be disposed of:

‡ into surface drains (outdoor drains)

‡ onto the earth

‡ by evaporation into a fume hood. Fume hoods are there as a safety precaution, not a disposal chamber and the venting of toxic chemicals into fume hoods should be kept to a minimum.

18.7.1. What may be poured down the sink

Organic solvents, halogenerated hydrocarbons, petrol, paraffin etc. may **never** be poured down the sink (except perhaps for a few millilitres of water miscible solvents such as alcohols and acetone). See below for how to dispose of organic solvents.

Small quantities of purely aqueous solutions may be poured down the sink provided that they do not contain potentially hazardous chemicals. Strong acids, alkalis, oxidising agents and reducing agents should be neutralised before disposal. The allowable amounts and necessary dilutions for sink disposal of various chemicals in aqueous solution are given in Table 1. This list is by no means exhaustive: further information is available in the Department Safety Library (e.g. manufacturer's catalogues).

TABLE 1

Maximum Allowable Concentrations for Disposal of Chemicals into the Sewage System

(N.B. **No** chemicals may ever be put into the outdoor surface drains)

CONTAMINANT	**ALLOWABLE CONCENTRATION (mg/dm^3)**
Calcium carbide, thallium, arsenic, mercury	0
Cadmium, silver	1
Sulphide, zinc, copper, nickel	5
Cyanide, SO_2, lead, chromium	10
Cl_2, unsaponifiable grease or oil	50
Ammoniacal nitrogen	100
HCHO	200
Saponifiable grease or oil	300
Sulphate	1800

18.7.2. Disposal of Organic Solvents

These should not be poured down the sink. Organic solvents can be grouped together into four categories for the purposes of disposal:

1) Highly toxic, reactive or smelly organic liquids e.g. benzene, pyridine, dimethyl sulphoxide.

2) Chlorinated organic solvents, not falling into category (1) e.g. Chloroform, carbon tetrachloride, CFC's etc.

3) Non-chlorinated solvents, miscible with water and not falling into category (1), e.g. alcohols, acetone.

4) Non-chlorinated solvents, immiscible with water and not falling into categories (1) and (2) e.g. toluene, hexane, diethyl ether.

Those in category (1) should be disposed of on an individual basis following the correct procedure laid down in each case. Those in categories 2, 3 and 4 should be collected together in labelled containers set aside for that purpose,

i.e. the chlorinated solvents should be collected in one container while the water miscible non-chlorinated solvents are collected in another and the water immiscible non-chlorinated solvents are collected in a third. If acids or alkalis are present in solvent waste, they should be neutralised before pouring the waste into the appropriate container. As with any chemicals these containers must be stored correctly (e.g. in a cabinet) and when full they should be given to the Workshop Supervisor for disposal.

18.7.3. Waste Solids, Toxic and Reactive Chemicals

Inert powdery material, e.g. silica gel and alumina, must not be placed in the ordinary waste bins but should be collected up in containers which are properly labelled and stored.

Many toxic and/or reactive chemicals can and must be rendered harmless by pre-treatment prior to disposal. The Aldrich Chemical Catalogue gives some advice as to how this can be done in a wide range of cases. The treatment procedure may yield an aqueous solution, which can safely be diluted and flushed down the sink (see section 18.7.1).

Containers of those toxic waste materials, which cannot be detoxified, should be properly packaged and labelled, and arrangements should be made with the Workshop Supervisor for collection and disposal. Labelling of containers should be in accordance with the approved Code of Practice "Classification and Labelling of Substances Dangerous for Supply", copies of which are available in the Chemistry Department stores. Where there is any doubt about the correct disposal method, the Department COSHH Co-ordinator or the University Health and Safety Officer should be consulted.

18.8. Bringing chemicals into the Department

Purchases of chemicals made through the Department are logged automatically. Those bringing hazardous substances into the Department by other means must inform the person responsible for maintaining the Department's chemical inventory (see Who's Who?).

19. Working with Lasers

19.1. The Hazards of Lasers

If a laser beam enters the eye it will be focused onto the retina and the resulting temperature rise (even if only a few degrees centigrade) can de-nature the proteins which make up the light sensitive elements of the eye, producing irreversible damage and possibly even effective blindness in that eye. This hazard is the subject of the safety information given here. However there are other hazards that laser users should also be aware of. The operation of many lasers requires highly lethal voltages and nobody except trained and expert personnel should tamper with the insides of a laser or its power supply: the voltage can kill you but the light can only blind you. A side effect of the high voltages present in many lasers is that ozone and nitrogen oxides can be formed in the air around the electrodes. Ozone, in particular, is a highly poisonous gas and if it reaches levels at which you can smell it (smells a bit like chlorine) then it is not doing you any good and you should do something about it.

19.2. Laser Safety Policy in the Physics Department

It is the policy of the Physics Department that all laser operations should be in accordance with the document "Safety in Universities: Notes of Guidance Part 2:1 Lasers" issued by the CVCP. This document is available in the Department Safety Library. The laser safety information given here is a very brief summary of the information in the Notes of Guidance.

19.3. The Departmental Laser Safety Officer

The Departmental Laser Safety Officer (see section 2) is responsible for the supervision of laser operations within the Department in accordance with the Notes of Guidance. Anyone in any doubt about laser safety should seek his/her assistance.

19.4. Registration of Lasers

The University Health and Safety Office keep a register of all lasers in the University. Any person bringing a laser into the Department, or building a laser in the Department, must register it both with the Health and Safety Office and with the Departmental Laser Safety Officer, before it is operated in the Department. Furthermore, all appropriate labels and engineering and administrative controls must be put in place before any newly acquired laser is operated in the Department.

19.5. Classification of Lasers

The aim of laser safety measures is to ensure that the "Maximum Permissible Exposure Levels" (defined in the Notes of Guidance) are never exceeded. Clearly, the higher the power and power density of a

laser, the greater is the risk and potential hazard. Lasers are therefore classified into 5 classes: 1, 2, 3A, 3B and 4 according to their potential hazards, - the larger the number the greater the hazard and therefore the more stringent the required safety measures.

Table 2 gives a summary of the hazards associated with each class of laser and the precautions required. Note that even a 1 mW laser will be in class 3B if its power density is above 2.5 mW/cm^2. Basically, the precautions required for classes 1, 2 and 3A pose little problem, although attention must still be paid to the general safety rules given in the next section - particularly in the case of class 3A lasers.

Lasers in classes 3B and 4 present major safety problems and may only be used in clearly defined "laser designated areas". Anyone installing such a laser must do so in accordance with the Notes of Guidance (particularly section 4.4) and in consultation with the Departmental Laser Safety Officer.

Table 2

Classification of Lasers

Class	Definition	Hazard	Precautions Required
1	Impossible to exceed any MPEL. (Extremely low power or totally enclosed and interlocked).	None	Appropriate safety labelling on the laser itself.
2	<1mW and <2.5 mW/cm^2	Natural aversion response (e.g. blink reflex) normally affords adequate eye protection. Never point the beam at anyone and never stare into the beam (the natural aversion response is easily overcome)	Appropriate safety labelling on the laser itself.
3A	<5mW and <2.5 mW/cm^2	As for class 2 except that intra-beam viewing is much more hazardous for class 3A than for class 2.	Appropriate safety labelling on the laser itself and at all points

			of access to the laser. Key operation. Beam shutter.
3B	<0.5W	Natural aversion response is too slow to protect the eye from damage. Specular reflection hazardous	Appropriate labelling. Key Shutter. Laser designated area (no leakages). Not for undergraduate teaching laboratories. Consideration given to safety interlocks
4	>0.5W	Serious eye damage can be caused by diffuse as well aspecular reflections.	Even greater caution than for Class 3B.

19.6. General Laser Safety Procedures

1) Never look into the beam.

2) When carrying out alignment procedures, and other adjustments and alterations which may give rise to unexpected beam paths or reflections, the laser beam power should be cut to the absolute minimum necessary (< 1 mW) by the adjustment of the power supply and aperture or by the introduction of suitable filters.

3) The laser and all components affecting the laser beam should be securely fixed to the bench so that they cannot be knocked out of alignment and hence give rise to unexpected beam paths and reflections.

4) Eliminate the chance of stray reflections by:

‡ removing wrist-watches and jewellery

‡ wearing a lab coat to cover shiny buttons, buckles etc.

‡ using anti-reflection coated optical components

‡ removing unnecessary apparatus and furniture from the laser area

‡ using components which will not shatter or craze in the beam

5) Operate lasers in areas separate from other work activities.

6) Use a suitable energy absorbing non-reflective beam-stop to terminate the beam.

7) Do not leave the key in a key switch when the laser is not in use. Ensure that the use of such keys is properly managed and controlled.

8) Do not leave lasers running unattended in areas where unauthorised people have access.

9) Potentially hazardous beams and reflections (both specular and diffuse) should be totally enclosed so that human access is not possible.

10) Never stare at a bright diffuse reflection. It may be much brighter than you think (the photosensitive cells in your eye saturate at quite low intensities).

11) Anyone using a class 3B or class 4 laser must be properly trained and must be familiar with sections 3 and 4.4 of the "Notes of Guidance".

20. Protection of Surface Drains from Outdoor Spillages

Outdoor surface drains are designed for carrying rain water straight to a local stream. When chemicals are used or spilled out of doors there is a great risk that the chemicals will get into the surface drains and cause a major pollution incident in the local stream.

In the event of an outdoor spillage the first concern must be for the safety of the people in the surrounding area, but following that the next concern should be to prevent the spillage from entering the surface drains: this can be done by using soil to stem the flow to the drain. The Safety Officer and University Health and Safety Officer should be contacted. In an emergency, call the Fire Brigade. (Dial 888). In the event of contamination of the surface drains, Severn Trent Water should be contacted immediately.

21. Waste Disposal and Recycling

The Environmental Protection Act places a legal obligation on all employers to recycle all waste material where reasonably practicable, - so recycling of office paper etc. is not just a good idea, - it's the law.

21.0.1. Chemical Waste, Solvents etc

This topic is covered in section 18.7.

21.0.2. Metal, Glass, Sharp Objects

Sharp objects must not be placed in the normal waste bins. Any scrap metal should be put in the scrap metal recycling skip provided in the yard outside the Mechanical Workshop. Glass should be put in the labelled bin in the Mechanical Workshop. Large amounts of glass should be taken straight to the glass-recycling skip outside the Chemical Engineering Department.

21.0.3. Batteries

Spent batteries should be put in the labelled bin in the Electronics Workshop. Batteries generally contain quantities of toxic heavy metals and the University has decided to treat them as chemical waste (which goes to special landfill sites). In future the toxic metals in spent batteries will be extracted and recycled. Don't use batteries unless you need to and, where batteries are required, consider using rechargeable ones.

21.0.4. Asbestos and Other Hazardous Material

Material which is suspected to contain asbestos or other hazardous substances should not be placed in the normal waste bins or skip. The Department Safety Officer and the University Health and Safety Office should be consulted.

21.0.5. Aluminium Cans

Receptacles for recycling aluminium cans are provided alongside drinks dispensing machines.

21.0.6. Paper

Sacks for paper recycling are situated at various points around the Department. The sack in the computer terminal room W2.31 is printout paper only while the others are for office quality paper. Do not put glossy paper, card, glued paper, envelopes, newspapers, telephone directories, glued brochures, sellotape, plastic, string etc into these sacks. Paper collection bins are provided for these.

22. Appendix A: Summary of the Royal Society of Chemistry scheme for determining the control measures necessary for operations involving hazardous substances.

What is presented here is a very brief summary of the scheme described in the booklet "COSHH in Laboratories" by the Royal Society of Chemistry. For work with "high hazard" or "extreme hazard" substances, the booklet itself should be consulted.

The essential steps of the scheme are as follows:

1) Use Table A1 to determine the hazard category.

2) Use Table A2 to estimate the exposure potential as "high", "medium" or "low".

3) Use Table A3 to establish the recommended containment regime, based on the hazard category and exposure potential.

If the recommended containment regime comes close to being in category 3 (special facility) then the COSHH Co-ordinator or Safety Officer should be consulted.

Table A1

General guidelines for determining hazard categories

EXTREME HAZARD	Substances of known or suspected exceptional toxicity (e.g. carcinogens)
HIGH HAZARD	All substances whose toxicity exceeds that of the medium hazard category, except for those known or believed to be so highly toxic as to merit special precautions (i.e. those in the 'extreme' category)
MEDIUM HAZARD	Substances meeting criteria for CPL classification as 'Harmful' or Irritant'
LOW HAZARD	Substances not matching criteria for CPL classification as 'Harmful' or 'Irritant'

TABLE A2

Typical basis for estimating exposure potential

Score	**1**	**10**	**100**
(A) QUANTITY OF SUBSTANCE	<1g	1-100 g	> 100g
(B) PHYSICAL CHARACTERISTICS OF SUBSTANCE	dense solids, non-volatile liquids, no skin absorption	Dusty solids, lyophilised solids, volatile liquids, low skin absorption	Gases, highly volatile liquids, aerosols, solutions that promote skin absorption
(C) CHARACTERISTICS OF OPERATION OR ACTIVITY	Predominantly enclosed system, low chance of mishap	Partially open system, low chance of mishap	No physical barrier, any operation where chance of mishap is medium or high

Exposure potential is estimated by multiplying the individual scores A x B x C :

A x B x C < 1000 ranks as 'Low' exposure potential 1000 < A x B x C < 10000 ranks as 'Medium' exposure potential.

A x B x C > 10000 ranks as 'High' exposure potential.

NOTE: Time factors such as frequency and duration of the activity should also be considered. Short duration tasks, involving a few seconds exposure at infrequent intervals, should not affect the initial estimate, whereas continuous operations on a daily basis would probably raise the estimate to the next higher category.

Table A3

Typical matrix for making a general evaluation of risk assessment and control determination

(Risk depends on hazard and exposure potential)

HAZARD CATEGORY (see Table A1)	EXPOSURE POTENTIAL (see Table A2)				
	Low	Medium	High		
Low	1	1	1		
Medium	1	2	3		
High	2	2 or 3	2 or 3		
Extreme	Risks presented by the handling of such substances are unsuited for this procedure and must be addressed on an individual basis				

Containment regime determined from the above:

1. Open bench

2. Fume cupboard (or other specially vented area)

3. Special facility

In addition to the above containment regimes, it may be necessary to specify personal protective equipment or other control measures, particularly where there may be exposure by the dermal route.

N.B. The detailed criteria for the assessment of hazard and exposure may vary as may the efficiency of containment regimes. If there is reason to doubt the adequacy of the containment to control the risks further advice should be obtained from the COSHH Co-ordinator.

23. Appendix B: Some chemicals which must be stored separately from one another

Partial list of incompatible chemicals (reactive hazards)

Substances in the left hand column should be stored and handled so that they can not possibly accidentally contact corresponding substances in the right hand column under uncontrolled conditions, when violent reactions may occur.

Acetic acid	Chromic acid, nitric acid, hydroxyl-containing compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Aceton	Concentrated nitric and sulphuric acid mixtures
Acetylene	Chlorine, bromine, copper, silver, fluorine, mercury
Alkali and alkaline earth metals, such as sodium, potassium, lithium, magnesium, calcium, powdered aluminium	Carbon dioxide, carbon tetrachloride and other chlorinated hydrocarbons. (also prohibit water, foam and dry chemicals on fires involving these metals - dry sand should be available)
Ammonia (anhyd.)	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrogen fluoride
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulphur, finely divided organics or combustibles
Aniline	Nitric acid, hydrogen peroxide
Bromine	Ammonia, acetylene, butadiene, butane and other petroleum gases, sodium carbide, turpentine, benzene, finely divided metals
Calcium oxide	Water
Carbon, activated	Calcium hypochlorite
Chlorates	Ammonium salts, acids, metal powders, sulphur, finely divided organics or combustibles
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, turpentine, alcohol, other flammable liquids
Chlorine	Ammonia, acetylene, butadiene, butane, other petroleum gases, hydrogen, sodium carbide,

	turpentine, benzene, finely divided metals
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulphide
Copper	Acetylene, hydrogen peroxide
Fluorine	Isolate from everything
Hydrazine	Hydrogen peroxide, nitric acid, any other oxidant
Hydrocarbons (benzene, butane, propane, gasoline, turpentine)	Fluorine, chlorine, bromine, chromic acid, peroxide
Hydrocyanic acid	Nitric acid, alkalis
Hydrofluoric acid, anhyd. (hydrogen fluoride)	Ammonia, aqueous or anhydrous
Hydrogen peroxide	Copper, chromium, iron, most metals and their salts, any flammable liquid, combustible materials, aniline, nitromethane
Hydrogen sulphide	Fuming nitric acid, oxidising gases
Iodine	Acetylene, ammonia (anhydr. or aqueous)
Mercury	Acetylene, fulminic acid*, ammonia
Nitric acid (conc.)	Acetic acid, acetone, alcohol, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids, flammable gases, nitratable substances
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen, flammable liquids, solids or gases,
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Phosphorus (white)	Air, oxygen
Potassium chlorate	Acids (see also chlorates)

Potassium perchlorate	Acids (see also perchloric acid)
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulphuric acid
Silver	Acetylene, oxalic acid, tartaric acid, fulminic acid*, ammonium compounds
Sodium	See alkali metals (above)
Sodium nitride	Ammonium nitrate and other ammonium salts
Sodium peroxide	Any oxidisable substances, such as ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulphide, glycerol, ethylene glycol, ethyl acetate, methyl acetate
Sulphuric acid	Chlorates, perchlorates, permanganates

* produced in nitric acid - ethanol mixtures

Arsenic materials	Any reducing agent *	Arsine
Axides	Acids	Hydrogen azide
Cyanides	Acids	Hydrogen cyanide
Hypochlorites	Acids	Chlorine or hypochlorous acid
Nitric acid	Copper, brass, any heavy metals	Nitrogen dioxide (nitrous fumes)
Phosphorous	Caustic alkalies or reducing agents	Phosphine
Selenides	Reducing agents	Hydrogen selenide
Sulphides	Acids	Hydrogen sulphide
Tellurides	Reducing agents	Hydrogen telluride

* Putting an arsenic alloy into a wet galvanized bucket has produced Arsine.