University of Leicester

Hazardous Chemicals

Guidance for University Departments and Functions

Safety Services Office

May 2010

GUIDANCE NOTES FOR DEALING WITH HAZARDOUS CHEMICALS

Contents

1. INTRODUCTION

Section 2 of the Health and Safety at Work Act 1974 places upon employers a duty to ensure, so far as is reasonably practicable, the health, safety, and welfare at work of all their employees. There is also a requirement under Section 3 that employers should ensure, so far as is reasonably practicable, that persons not in their employment who may be affected thereby are not exposed to risks to their health and safety.

These general duties are reinforced by the **Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended)**. Departments and individuals must place great importance on maintaining high professional standards of safety and awareness in their handling of chemicals. Safe working practices will prevent harm to people and damage to equipment and buildings.

The COSHH Regulations apply to all areas of work in the University; however the emphasis in these guidance notes is on work in laboratories. This document concentrates mainly on practical advice to assist users with

(i) recognition of hazards and assessment of risks associated with the use of chemicals

and

(ii) the safe handling of hazardous chemicals from acquisition to disposal.

This guidance document should be read in conjunction with the University guidance documents **Laboratory Safety**, **Carcinogens**, **A Guide to DSEAR in the University** and **COSHH assessments**.

Terms, Definition and Scope

Rules:	Instructions that must be followed
Code of Practice:	Good practice that must either be followed or be replaced by equivalent good practice
Guidance Notes:	Guidance which should be consulted when decisions relating to health and safety are made within Departments.

Advice

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2.RESPONSIBILITIES IN DEALING WITH HAZARDOUS CHEMICALS

Management responsibility for safety resides with Heads of Department, and the duties of Heads of Department are set out in the University document **Laboratory Safety**. This document also covers the rules and code of practice for postgraduate research work and the supervision of undergraduate students in the laboratory.

Departments deal with ranges and types of hazardous chemicals which differ widely. There are substantial variations in the scale of use of hazardous chemicals as well as the frequency of use, the expertise of users and the availability of specialised facilities. Thus, the individual Departmental Safety Booklets are essential in providing a clear framework appropriate to the needs of each Department, and should contain local rules and procedures governing the following:

a) General Laboratory Practice.
b) Laboratory Practice with Hazardous Materials.
c) Acquisition, Storage and Disposal of Hazardous Materials.

Each member of a Department should be fully aware of local rules and procedures and must operate in accordance with these rules.

It is important that all persons dealing with hazardous substances are aware of:

- hazards and how to recognise them;
- possible consequences of exposure or mis-use;
- precautions to be taken;
- action in case of an emergency.

Whatever the particular circumstances, four general principles apply.

(i) Hazardous chemicals should be handled only if their use is justified by the importance of the experiment and if no safer alternative exists.

(ii) Hazardous chemicals should be handled only in suitable areas with adequate equipment for their containment and for the protection of staff.

(iii) Work with hazardous chemicals should be carried out only by users who are properly informed and have been given adequate training.

(iv) Work with hazardous chemicals, including the disposal of waste, should be carried out according to clearly understood procedures.

No one should use any substance unless they are satisfied that they can do so (from acquisition to disposal) without putting themselves or others at risk.

3. IDENTIFICATION OF CHEMICAL HAZARDS

*This section should be read in conjunction with the University documents **COSHH Assessments**, **Carcinogens**, and **A Guide to DSEAR in the University** where further information on identification and assessment of chemical hazards can be found.*

'There are no safe substances, only safe ways of handling substances.'

Bodily contact with all substances in the laboratory should be minimised. Nevertheless, some substances demand more stringent precautions than others and it is important that hazards associated with chemicals should be easily recognised.

3.1 Nomenclature

Care must be taken in identifying substances correctly. Trivial names, synonyms and brand names can lead to confusion and their use can mask hazards.

Small errors in nomenclature (or even spelling) can make an enormous difference in structure and/or associated properties, e.g.

- 1-naphthylamine (α-naphthylamine) and 2-naphthylamine (ß-naphthylamine) differ markedly in carcinogenicity.

- fluorine and fluorene; one is a corrosive, toxic gas and the other an aromatic hydrocarbon.

Where there is any doubt about name or structure, further information or advice should be sought.

3.2 Hazard Identification

The symbols and terms shown below are standardly used to identify hazards on substances and mixtures. Symbols on the left hand side conform with the Chemicals (Hazard Information and Packaging for Supply) Regulations 2009. However, Regulations in this area are currently changing. Between 2010-2015 there will be a phased introduction of the Regulation on Classification Labelling and Packaging of Substances and Mixtures (known as the CLP Regulation). This Regulation will introduce new, globally harmonised, warning symbols and warning and precautionary statements for labels, which will replace the current risk and safety phrases. The new symbols are shown in the right hand column below.
During the phased introduction of the new Regulation, either symbol may be used to identify a given hazard.


Oxidising


Flammable, highly flammable, extremely flammable


Explosive


Corrosive


Irritant, harmful

Long term health effects (Carinogen, Sensitising)


Toxic, very toxic, Carcinogen, mutagen, teratogen


Dangerous for the environment

Where any hazard/risk phrases apply to a substance, a potential user must understand the meaning of these terms before using the substance.

It is important to distinguish between the terms avoid (advisory) and prevent (mandatory) when used, for example, in safety phrases relating to inhalation or skin contact.

The fact that a compound is known to have toxic properties does not imply that it cannot be used. Such substances can always be handled safely if proper precautions are taken.

3.3 Sources of Hazard Information

Hazard information is now easy to obtain for all commercial substances because manufacturers and suppliers bear full responsibility for the proper classification, packaging and labelling of dangerous substances and are obliged to provide this information when requested. All containers carry clear

risk phrases on the labels; where properties have not been fully investigated, warnings will often err on the side of caution. Old samples or non-commercial samples may bear inadequate warnings.

Material safety data sheets are available from suppliers and should be sent with products when they are ordered. They can be also requested prior to ordering a product, to allow a pre-assessment of its properties. Many manufacturers have all product safety sheets on their website to view. Additionally, most chemical catalogues contain information on properties of substances (and often on handling and disposal).

General texts on laboratory safety offer critical assessments of properties and handling procedures produced by practising chemists.

Guidance material may also be found on the Health and Safety Executives website. www.hse.gov.uk This includes the current EH40 document containing workplace exposure limits.

Information on substances may also be come from professional bodies, trade unions or others who have experience in using the substance, and who have gathered information as a result of previous use.

Note. **If no information can be found on the substance in question (or on similar substances) then it must be treated as a potentially serious hazard. All new and untested substances should be regarded as toxic until proven otherwise.**

Emergency Information

Supplier's 'Hot Lines' e.g.

Fisher	9-5pm Monday-Friday:	**01509 231166** (ask for Chemsafe assistance).
	All other times:	**07966 206519** (a message will be taken and the 'on duty' Chemsafe team member will be contacted).

In the event of exposure to a hazardous chemical, go to the local accident and emergency department (Leicester Royal Infirmary), taking with you all relevant information on the exposure (chemical name, amount exposed to, COSHH form, MSDS etc.), where clinicians will be able to advise and treat you.
Where possible phone ahead to ensure the clinicians are aware of your arrival.

3.5 Immediate Hazards/Acute Poisons

Substances which pose immediate hazards (flammable or potentially explosive compounds and substances having acute toxic effects) are usually easy to identify from supplier's data or from standard sources.

The distinction is emphasised between acute toxicity (where damage can result from single or short-duration exposure), and chronic toxicity (where damage is caused after repeated or long-term exposure or becomes evident only after a long latency period).
Examples of acutely toxic substances include hydrogen cyanide, hydrogen sulphide and nitrogen dioxide; chronic toxins include all carcinogens and many metals and their compounds (such as mercury and lead and their derivatives).

3.6 Substances of Chronic Toxicity including Carcinogens, Mutagens and Teratogens

These substances may, of course, show acute toxicity but the carcinogenic, mutagenic and teratogenic effects are likely to be delayed and irreversible. Good design of apparatus and experiments (together with effective control measures) are important in avoiding both short-term intermittent exposure and long-term exposure, even at low doses.

Mutagens and Teratogens

Mutagens cause cell mutations. Teratogens cause foetal deformities.

Women who are pregnant (or are likely to become pregnant) are at particular risk if exposed to these compounds. (University guidance on New and Expectant Mothers at Work is available on the Safety Services Office website). Men are at risk from mutagens since they may cause heritable changes in gene structure.

Carcinogens

The COSHH regulations define carcinogens as follows:

i) Substances or preparations which when classified in accordance with the Chemicals (Hazard Information and Packaging for Supply) Regulations 2009 are in the category of danger, carcinogenic (category 1) or carcinogenic (category 2).

ii) Substances or preparations listed in Schedule 8 of the COSHH regulations and any substance or preparation hazardous to health arising from a process specified in Schedule 8

Notes for guidance concerning work with carcinogens can be found in the University guidance document **Carcinogens**.

3.7 Hazards Requiring Local Notification and/or Prior Approval

The University document **COSHH Assessments** includes the requirement that Heads of Department should ensure that a copy of the assessment is sent to the University Safety Services office when:

i) Monitoring of exposure and/or health surveillance required.
ii) Where is any doubt whether exposure can be adequately controlled.
iii) If the substance is on the Anti-terrorism, Crime and Security Act pathogen/toxin list (http://www.le.ac.uk/safety/documents/pdfs/schedule5list.pdf).

Other restrictions and controls on the use of carcinogens within the University are listed in the University document **Carcinogens**.

In addition to these defined circumstances, the use of many other hazardous substances and hazardous procedures may pose sufficient risk (in case of accident or failure of services) that they should not be used without prior notification and/or approval within departments. Departments should develop a mechanism for recognising and assessing those substances and procedures which might, in case of accident or failure of services, put at serious risk not only the user, but also persons who are **not** involved in their use. This will follow from risk assessment.

In such cases, prior notification should be given:

a) to designated persons in the Department, (e.. Departmental Safety Officer)
and
b) to people working in or near the area concerned.

This rule is intended not only to safeguard the health and safety of workers in the vicinity but is also for the benefit of the Emergency Services in the event of fire or other accident.

Examples
Departments should consider the following examples of situations where local notification may be required.

- major fire or explosion hazards,

- poisonous or toxic substances where the nature of the substances or the scale of use might pose serious risks in case of escape (including toxic gases, Appendix 2.),

- carcinogenic, mutagenic or teratogenic substances where the nature of the substances or the scale of use might pose serious risks in case of escape,

- irritant substances or substances with strong odours (e.g. sulphides, thiols etc.) which do not pose a significant health risk in very small quantities but may be detected and cause concern beyond the area of use (giving rise, for example, to fears of gas leaks).

The Departmental Safety Handbook should lay down clear rules concerning notification.

4. ASSESSMENT OF RISK IN USING HAZARDOUS CHEMICALS

*This section should be read in conjunction with the University documents **COSHH Assessments** and **A Guide to DSEAR in the University** where further information on the assessment of risk in using hazardous chemicals can be found.*

The Assessment of Risk under the COSHH Regulations must be carried out in accordance with the Approved Code of Practice and **COSHH Assessments** published by the University.

Risk Assessments must be made using the COSHH assessment form published by the University, or using the COSHHatron computer programme. Full guidance on the completion of the form and further information on the COSHHatron is given in the University document **COSHH Assessments**

A RECORD OF THE HAZARDS ASSOCIATED WITH A PARTICULAR SUBSTANCE IS NOT A RISK ASSESSMENT

The **hazard** presented by a substance is its **potential** to cause harm.

The **risk** from a substance is the **likelihood that it will cause harm in the actual circumstances of use and the consequence of the hazard potential being realised.**

Thus, **RISK = likelihood x consequence**

The determination of exposure potential provides information which can be used to evaluate both the likelihood of exposure and the potential consequences. The degree of exposure to a hazardous substance is related to the nature of the substance and the circumstances of its use. Exposure to a volatile substance which is used in large amounts in an open system will clearly be appreciably greater than exposure to a crystalline solid when a small quantity is being used in a sealed system. If the volatile substance is harmful by inhalation, the certainty of exposure under the conditions described and the consequences resulting from exposure to large amounts of the substance may mean that the risk is considerable. If the crystalline substance is very toxic by ingestion, the consequences of exposure by that route will be severe but, in a sealed system, the likelihood that harm will be caused is very low and so the risk is also very low.

Exposure Potential depends on:

- type of use
- quantity of substance
- physical characteristics of the substance (solid, powder, liquid, gas, solution)
- frequency of use
- experience of user
- design of apparatus; experimental techniques used
- place of use (containment facilities available)

The risk assessment of a given substance is likely to vary substantially according to these factors. A single risk assessment will therefore not necessarily cover the likely variation of these factors in a range of uses.

Risk assessment requires the sound judgement of Competent Persons designated by Heads of Departments.

5. ESTABLISHMENT OF APPROPRIATE PROCEDURES FOR DEALING WITH HAZARDOUS CHEMICALS

The following notes identify major areas which should be covered by a Departmental Code of Practice and embodied in the Departmental Safety Booklet. Many of the points mentioned below are covered by University Rules and Codes of Practice which are listed in the **Laboratory Safety** guidance but these are not necessarily cross-referenced.

5.1 Risk Assessement

Information should be gathered and risks assessed (as previously discussed). The exercise of risk assessment may form part of the education of undergraduates and technical staff involved in the use of hazardous substances. At a research level, an intrinsic part of the consultation between a member of the academic staff and a research worker on current and proposed activities will be the assessment of risk and completion of risk assessment forms.

5.2 Control measures

When selecting controls, you should consider the hierarchy of control. Using the top level controls you are more likely to effectively control the risk of injury to staff and others in the area. Reliance of lower level controls will mean that the risks of injury in the workplace are greater.
The hierarchy of control is:

- Elimination
- Substitution
- Reduction
- Isolation
- Safe systems of work, good housekeeping
- Information, instruction, training and supervisions
- Personal Protective Equipment

Contact with all substances in the laboratory should be minimised (due consideration being given to exposure to dusts, vapour and aerosols as well as oral ingestion, skin contact and injection). Eating, drinking, smoking and the application of cosmetics are strictly forbidden in areas where chemicals are used.

Good modern practice should be incorporated into the design and execution of experiments. Protective clothing and equipment should not be used in an attempt to compensate for poor or out-dated technique.
It should be noted that fume cupboards are fail-safe devices; **fume cupboards are not to be used as a primary means of preventing exposure.**

Appropriate protective equipment (safety spectacles, face shields, gloves, protective clothing ,fume cupboards) must be made available and must be used as necessary, where identified by the risk assessment.

5.3 Information, Instruction and Training

Departments must ensure that students, visitors, and all employees of the University have the information, instruction and training necessary to carry out their work effectively and without risk to themselves or others.

5.4 Purchase of hazardous chemicals

The intending user and the Departmental Purchasing Officer (or equivalent person in charge of purchasing) should note reference to known hazards giving particular attention to substances which are very toxic, toxic, known/suspect carcinogenic/mutagenic/teratogenic agents or are reactive chemical hazards. Departments should require that the person signing the purchase requisition slip should obtain relevant data before use, should understand the nature of the substance being ordered and should transport, store and use it only in accordance with current Codes of Practice and the relevant Risk Assessment. Information concerning serious hazards should be made available to the receiving and issuing sections of Departmental stores.

The date of acquisition of hazardous substances should be recorded on the label of the sample container. Substances which are left unused for long periods may then be identified easily. If the lifetime is limited or if hazards are likely to develop during storage (e.g. peroxide formation in ethers) then the dates of acquisition and opening should be specified together with a recommended date for checking and/or disposal. Periodic checks should be made of substances in storage.

Minimum quantities of material should be purchased. It is then easier to dispose of any excess. The tendency to 'save money' by buying large quantities of chemicals (at lower cost per gram) should be avoided in the case of toxic substances and substances which deteriorate in storage or after opening the container, bearing in mind the potential wastage of excess or outdated substances and the cost of their disposal.

5.5 Storage of hazardous chemicals

Flammable, explosive, corrosive substances and oxidising substances
The separate storage of flammable substances, of explosive substances, of corrosive substances and of oxidising substances in suitable containers should be normal practice. Useful lists of incompatible chemicals (reactive hazards) are available as an appendix to this document. Compounds which are very toxic, dangerous for the environment, carcinogenic, mutagenic or teratogenic should be stored separately from other chemicals in a secure area; they should not be on open access.

These recommendations apply to substances in Departmental stores and substances in laboratories. Flammable solvents are a particular hazard; storage in laboratories should be confined to the minimum amounts required for daily work. Winchester bottles of solvents must not be left in the open laboratory unless in use; they should always be returned to a solvent storage cabinet which should contain a maximum of 50 litres of flammable liquid. Solvents (in glass bottles or cans) should never be left on the floor. If bottles are used for the storage of solvent, safety coated versions should be used. Using these decreases the chances of breaking the bottle by dropping it, and if a bottle should break, the glass fragments are kept inside the polymer coating. The coating will contain the solvent for a short while. Vented caps should also be used to release any gradual build-up of pressurein the solvent bottles.
Anyone planning on using solvents in the laboratory should read the guidance document **A guide to DSEAR in the University**, where further information can be found before starting the work.

Careful consideration should be given to storage in refrigerators, cold rooms and deep freezers. Samples in refrigerators must be in suitable sealed, and properly labelled, containers which cannot fall over; it is a wise precaution to place any vessel which contains hazardous substance inside a second unbreakable container (a labelled can, box or heat-sealed heavy plastic bag as appropriate) in case of accidental spillage or leakage.

Substances which give off flammable vapours can form explosive air/vapour mixtures in refrigerators. Sources of sparks should be removed by fitting refrigerators with external electrics

(removing any internal light fittings and re-positioning any internal thermostat on the outside of the casing). Departments should modify all refrigerators which were originally designed for general domestic use and which might be used for flammable substances, even in small quantities.

Schedule 5 substances
A number of pathogens and toxins are listed under Schedule 5 to the Anti-terrorism, Crime and Security Act 2001 (Modification) Order 2007 (2007/929). This list can be found at:
http://www.le.ac.uk/safety/documents/pdfs/schedule5list.pdf
There are strict measures regarding the storage, use and notification of pathogens and toxins on this list. Therefore, the Biological and Chemical Safety Officer must be contacted to obtain guidance on the storage and use substances, before they are brought to the University.

5.6 Issue and Use

Local regulations covering notification or prohibition of the use of certain chemicals (e.g. carcinogens, toxins) should be brought to the attention of all users of chemicals.

Alternatives to hazardous substances should be used wherever possible. Clear, written instructions for the use/storage/transport and disposal of all hazardous compounds should be available. There should be a clear indication of the nature of any risks involved.

Compounds which have been identified as high-risk substances should only be issued through the appropriate laboratory store and should require the prior written approval of a member of staff. Return of unused substance to the store should be recorded. This procedure should not be by-passed by academic staff or by laboratory demonstrators and it will remain the responsibility of the user to dispose of waste etc. by safe methods with the help of demonstrators or staff where necessary.
Departments may wish to apply this requirement more widely, for example to highly flammable, corrosive and explosive substances.

5.7 Disposal of Hazardous Substances

Careful consideration should be given to methods for the ultimate disposal of hazardous material *before* they are used. This review should include stock chemicals and reaction products (including reaction wastes).

All stock chemicals should be inspected periodically and those which are not needed should be removed. Particular attention should be given to materials which deteriorate on storage; such substances should not be allowed to accumulate.

Separate regulations cover the disposal of clinical and radioactive waste.

Those who create hazardous waste are responsible for its safe and prompt disposal. No disposal procedure should be attempted until a safe method has been identified or designed. If an acceptable procedure is not found, the user should contact the manufacturer of the substance or seek advice from Departmental or University advisers.

A heavy responsibility rests with research supervisors to ensure that graduate students and other research workers do not abandon hazardous substances when they leave the University. A similar responsibility is placed upon senior research workers when they leave the University.

Disposal of soluble waste to drains

No waste materials should be disposed of down the drains unless the user is satisfied that this is a safe and acceptable procedure. The disposal of chemical waste is covered by The Hazardous Waste (England and Wales)Regulations 2005. Substances on the Government 'red list' (Appendix 2) are not to be discharged into the public sewage system. In addition to these proscribed substances, there are three general classes of compounds which the water companies wish to limit:

- toxic substances;
- substances harmful to the environment;
- substances having an adverse effect on sewage works (substances which affect the culture or pose hazards to workers).

Examples of such substances are given in the appendices, but this list should not be considered to be complete. The discharge of these substances to the drains must be reduced to a minimum and preferably avoided altogether. However, when necessary, *small amounts of dilute* washings may be disposed of via the drains (with copious amounts of water) in the light of a responsible assessment of the risks. The assessment of what constitutes a 'small amount' must depend on professional judgement, bearing in mind the concentration levels at which the substance(s) are toxic or otherwise harmful.

Larger quantities of such substances must not be put down the drain but must be disposed of by an approved route.

Many substances can be made safe chemically prior to disposal to drains with copious amounts of water.

Chemical Treatment prior to disposal

Safe procedures for disposal of many common materials can be found in specialised texts, commercial catalogues, or in standard reference works. Certain wastes may present an obvious hazard because of their intrinsic reactivity, volatility, flammability, or strong odour but an equally important factor is toxicity which may cause problems locally or at the sewerage treatment stage. However, it may be possible (and is sometimes preferable) to make some materials safe by chemical treatment before disposal with solid waste to drains.

Selected examples are listed below. *In all cases, it is important to follow well established procedures which make use of controlled conditions and to limit the scale of the procedure. Some reactions can generate considerable heat; the addition of strong base to strong acid, for example, is potentially dangerous and should not be attempted except in dilute solution.*

- Hydrolysis (under controlled conditions) of toxic organic compounds containing active halogens (e.g. lachrymatory halides such as benzyl chloride and bromide) using sodium hydroxide solution.

- Neutralisation (under controlled, dilute conditions) of strongly acidic or basic materials prior to disposal to drains.

- Precipitation of toxic metals from aqueous solution by raising the pH.

- Conversion of acrylamide into polyacrylamide prior to disposal.

- Oxidation of thiols (mercaptans), or hydrazines using a slight excess of aqueous hypochlorite.

- Absorption of osmium tetroxide on to unsaturated materials such as olive oil or milk powder prior to disposal.

Disposal of solvent residues and other volatile materials

Solvent residues (apart from moderate amounts of non-hazardous, water-miscible substances) must not be poured into sinks or other drains. Suitable residue containers should be available (separate collection of chlorinated and non-chlorinated solvents for ultimate incineration is strongly recommended). Containers of solvent residues must not be allowed to accumulate in laboratories and fume cupboards; they must be returned to the designated store at frequent intervals, or as soon as full, for disposal. Vented caps should be used on storage vessels to release any gradual build-up of pressurein the waste solvent bottles, and any glass storage vessels used should be of the "break-safe" variety.
If waste solvents contain substances in solution which pose any hazard or are apt to form toxic or corrosive substances on hydrolysis, oxidation etc., they should first be treated to render them harmless.

Fume cupboards are not to be used as a means of 'disposing of' volatile, hazardous substances used in experimental work or produced during experimental work.

Disposal by Waste Disposal Company

The University arrangements for the centralised disposal of hazardous waste are described in the University guidance document **Waste Disposal**. Briefly, the disposal of hazardous chemical waste (including solvents) is organised on behalf of the Laboratory Management Group, representing the technical and administrative interests of Managers, Superintendents and Chief Technicians in University Departments and Functions.
As and when required, collection is arranged and a contract awarded to an authorised contractor, for off-site disposal by incineration and/or other appropriate methods. The frequency of collection is dictated by collective Departmental needs and may vary according to demand. In the past, however, two-three collections each year have been found appropriate.

Empty Containers

Empty containers must be rinsed and made safe before disposal; labels should be removed in order to prevent unnecessary concern to persons handling the containers later.

Existing Stocks of Hazardous Substances

Department stores and individual laboratories may still contain old stocks of substances which are now classified as hazardous, or have deteriorated with time to form a hazardous substance. It is probable that many of these will carry inadequate warnings. Departmental Safety Officers should coordinate Departmental action (i) to identify hazardous substances and to label them appropriately and (ii) to ensure that adequate information is available and control exerted. Carcinogens should be identified and disposed of as matter of urgency. The opportunity should also be taken to dispose of hazardous substances which have deteriorated or are surplus to requirements. Such checks of stock should be carried out on a regular basis.

5.8 New Compounds/Research Samples

Information concerning how to deal with hazardous substances produced during the course of research and teaching carried out within the University should be included in Departmental Codes of Practice. Research workers should try to anticipate harmful properties of new compounds where possible, by analogy with related, known compounds. Where properties are not known, new compounds should be treated as hazardous.

The Registration, Evaluation, Authorisation & restriction of Chemicals (REACH) Regulations may apply in certain circumstances when manufacturing or transferring hazardous substances.
A major part of REACH is the requirement for manufacturers or importers of substances to register them with a central European Chemicals Agency (ECHA), supported by a standard set of data on that substance. The amount of data required is proportionate to the amount of substance manufactured or supplied.
REACH applies to substances manufactured or imported into the EU in quantities of 1 tonne per year or more. Generally, it applies to all individual chemical substances on their own, in preparations or in articles. If you do not register your substances, then the data on them will not be available and as a result, you will no longer be able to manufacture or supply them legally, i.e. no data, no market!
Further information on REACH, and its implications for manufacturers, importers and end users can be found at: http://www.hse.gov.uk/reach/ , with bitesize information leaflets found at: http://www.hse.gov.uk/reach/bitesize.htm

Research workers who introduce into the University dangerous or hazardous substances (or who make such substances) must control and eventually dispose of those substances.

Details of research samples and gifts of chemicals received by research workers should be notified to Heads of Department. It may be practical for each Department store to record and issue such substances. Departments should establish a Code of Practice covering substances introduced into the University by visitors.

5.9 Transfer of Hazardous Substances

When flammable, toxic or other hazardous substances are transported within laboratories, appropriate carriers should be used for anything other than small bottles.

Hazardous substances will sometimes be repackaged and/or transferred to other laboratories. 'Offspring' quantities of a chemical should not be separated from the 'parent' container for transfer elsewhere (another laboratory, institution or country) unless the information on the parent compound is duplicated on the 'offspring' and the new container is at least as strong and well-sealed as the original.

Transfer of a hazardous chemical to other institutions or countries should be notified in writing to the home Department specifying substance, hazards, quantity, packaging standard, reason for transfer and attesting that adequate information is to accompany it. When a hazardous chemical is forwarded to another institution then the forwarder is acting as a supplier and the Chemicals (Hazard Information and Packaging for Supply) (CHIP) Regulations will apply (please see section 3.2 where a summary of the upcoming changes to these regulations is given). These regulations require the supplier to:

-identify and classify the hazards associated with the chemical substance

-provide recipients with a detailed safety data sheet which will enable them to take the necessary measures for the protection of health and safety at work and the environment.
-use safe and suitable packaging
-provide information to the receiver by way of labelling (name of the substance, appropriate danger symbols, risk and safety phrases, EEC number and name, address, telephone number of supplier)

When the chemical has been initially supplied by a commercial source, retention of the the original labelling and packaging and duplication of the original safety data sheet should be sufficient to comply with these requirements. If in doubt, consult the Safety Services Office.

The CHIP Regulations are currently being phased out, with the new Classification, Labelling and Packaging (CLP) Regulations, incorporating the Globally Harmonised System, being phased in over a period of time. During this transitional period, substances and mixtures being transferred must be labelled as below:

Substances:

20th January 2009 – 1st December 2010: Suppliers must classify substances according to CHIP, and may continue to label and package them according to regulations 6 to 11 of CHIP. However they may as an alternative choose to classify, label and package substances according to CLP. In this case, they must in addition continue to classify under regulation 4 of CHIP, but the requirements on labelling and packaging in regulations 6 to 11 of CHIP no longer apply.

1st December 2010 – 1st June 2015: Suppliers must classify substances according to both CHIP and CLP. They must label and package according to CLP.

1st June 2015 onwards: Suppliers must classify, label and package according to CLP.

Preparations [mixtures]:

20th January 2009 – 1st June 2015: Suppliers must classify preparations according to CHIP, and may continue to label and package them according to regulations 6 to 11 of CHIP. However they may as an alternative choose to classify, label and package mixtures according to CLP. In this case, they must continue to classify in addition under regulation 4 of CHIP, but the requirements on labelling and packaging in regulations 6 to 11 of CHIP no longer apply.

1st June 2015 onwards: Suppliers must classify, label and package according to CLP.

The requirements of the carrier should also be strictly observed. Any substances entrusted to any carrier should include information regarding the person to contact in case of damage or other emergency.

On occasion, it may be necessary to transport hazardous chemicals by road to other sites e.g. for field trips. In these circumstances, users should consult the University guidance document **Transport of Dangerous Goods by Road.**

5.10 Accidents/Emergency Procedures

Following a proper Risk Assessment, users will be aware of, and prepared for, the hazards which an accident can present and will be familiar with proper methods for dealing with spillage and disposal.

Departments should have clear regulations covering action to be taken in case of emergencies involving spillage/escape of hazardous substances, injury, fire, explosion, etc. These regulations should cover both minor incidents and major emergencies which threaten the safety of occupants of a building and require immediate evacuation.

In any incident, the safeguarding of life and health is paramount and should not be compromised in order to protect equipment or buildings

Reporting of Accidents

University policy requires that all accidents should be reported to the University Safety Office. Forms are available on the Safety Services website for making these reports. In accordance with the **Reporting of Injuries, Diseases and Dangerous Occurrence Regulations (RIDDOR) 1996**, the University reports certain categories of accidents to the HSE who may decide to carry out their own investigations. The University guidance document **Reporting of Injuries Diseases and Dangerous Occurrences at Work** gives further information on the University arrangments for accident reporting.

In the event of a major incident, an incident which may have effects beyond the Department, or in any case where publicity may arise, it is important to ensure that there is good communication within the University. The Director of Safety Services should be informed immediately and the Press and Publications Office should be made aware of any requests from the press for interviews or information. The Registrar must be informed of major incidents involving the University or members of the University staff carrying out University duties, particularly where members of the public may be put at risk or where there is public interest.

5.11 Unaccompanied Work/Unattended Experiments

Lone working is not covered by any specific piece of legislation and, indeed, there is no general legal prohibition on working alone. However the broad duties placed on employers by the Health and Safety at Work Act and Management of Health and Safety at Work Regulations still apply and prohibition of lone working is included in some regulations that relate to particular high risk situations, such as work in confined spaces, or carrying out fumigations.

The University is required to assess risks relating to lone working activities and to put in place measures to eliminate the risks or to control them.Senate has decided that work of a potentially hazardous nature should only be conducted if at least one other person is within hailing distance. Anyone unsure of a technique should not use such techniques out of normal hours.
Heads of Department must ensure that when lone working is planned:

- **i)** adequate assessment of the associated risks is made,
- **ii)** any necessary additional precautions are taken
- **iii)** procedures and precautions are fully documented and made available to all affected parties

The University guidance documents **Laboratory Safety** and **Lone Working** provide further information regarding working alone.

Equipment in Continuous Operation

Apparatus which must be left in operation continuously (e.g. spectrometers, vacuum pumps, ovens, thermostats, air-conditioning etc.) should carry a label signed by the staff member responsible for the apparatus and bearing instructions concerning action to be taken in case of emergency. The instructions should be clear and understandable by a layman (such as security staff).

Any continuous use of water should involve safe, permanent connections. Appropriate safety devices should be incorporated (e.g. non-return valves on pumps).
Any heating device in an apparatus which operates overnight or on a permanent basis should be regulated by a variable transformer ('simmerstats' or other bimetallic regulators should not be used in overnight work).
All Equipment should be checked and serviced regularly.

Departments must establish protocols which cover the arrangements for experiments which are to be left running overnight or over weekends. Protocols must be approved by the Head of Department. Experiments involving water, cooling, heating and/or stirring (excluding magnetic stirring) should be carried out only in rooms/areas designated as appropriate for overnight work. Exceptions may be agreed within a department for experiments involving small quantities of substance which are to be used in a permanent apparatus such as a fixed gas line or a spectrometer. Such use should be agreed by the Departmental Safety Officer or Safety Committee and should be sanctioned by the Head of Department.

Unattended apparatus operating outside normal working hours must be accompanied by a card bearing the date, the signature of a member of the academic staff and instructions concerning action to be taken in an emergency. Each experiment should be considered separately; 'blanket' permission should not be given.

Experiments posing serious hazards should not be left unattended at any time.

5.12 Use in Animal Experiments

Research workers planning to use hazardous chemicals in experiments involving animals **must** consult the Director of Biomedical Services who will establish if the work is authorised under the Animals (Scientific Procedures) Act 1986. The Director will also identify safety aspects and the user will supply a COSHH Risk Assessment form. A protocol which includes all experimental procedures should be available in the Unit before work is started.

Any member of staff bitten or scratched by experimental animals, or accidentally injected during dosing, should report immediately to the Director of Biomedical Services or his deputy and their Head of Department; The incident must also be recorded on an accident form and should be reported to the University Safety Office.

5.13 Security

University Departments are normally open to students and visitors. There should be control of access, where necessary, to areas in which hazardous substances are used or hazardous procedures are carried out. Clear warning notices should be posted to indicate areas where hazardous/toxic substances are used.

Steps should be taken to minimise the risk of loss or accident as a result of ignorance or mischief. Secure areas/cupboards should be available for toxic compounds and for substances posing significant reactive or physical hazards. Persons entering or leaving buildings 'out of hours' should ensure that doors are locked.

Special care is needed to ensure the safety of samples 'in transit' and to ensure that these substances present no risk to the carrier or to any other person.

Schedule 5 substances

A number of pathogens and toxins are listed under Schedule 5 to the Anti-terrorism, Crime and Security Act 2001 (Modification) Order 2007 (2007/929). This list can be found at: http://www.le.ac.uk/safety/documents/pdfs/schedule5list.pdf

There are strict security measures regarding the storage, use and notification of pathogens and toxins on this list. Therefore, the Biological and Chemical Safety Officer must be contacted to obtain guidance on the storage and use substances, before they are brought to the University.

6. References

University documents

Laboratory Safety
http://www.le.ac.uk/safety/documents/pdfs/labsafety.pdf

COSHH Assessments
http://www.le.ac.uk/safety/documents/pdfs/coshh-guide-0012.pdf

COSHH Assessment form
http://www.le.ac.uk/safety/forms/index.html#c

Carcinogens
http://www.le.ac.uk/safety/documents/pdfs/carcinogens-guide.pdf

DSEAR
http://www.le.ac.uk/safety/documents/pdfs/dsear.pdf

Waste disposal
http://www.le.ac.uk/safety/documents/pdfs/wasteguide2009.pdf

All other University documents can be found at: http://www.le.ac.uk/safety/documents/index.html

Textbooks

Bretherick's Handbook of Reactive Chemical Hazards, 7th Edition (2006). Two Volume Set.

HSE Publications/Information

COSHH Regulations http://www.hse.gov.uk/pubns/priced/l5.pdf

CHIP Regulations http://www.hse.gov.uk/chip/

REACH Regulations http://www.hse.gov.uk/reach/ and http://www.hse.gov.uk/reach/bitesize.htm

EH40 List of approved workplace exposure limits http://www.hse.gov.uk/COSHH/table1.pdf

Other Useful websites

Physical and Theoretical Chemistry Laboratory, Oxford: http://physchem.ox.ac.uk/msds
This website is a source of general information about the safety and potential hazards of chemicals and should not be used in isolation when making assessments of risk.

Sigma-Aldrich Website: http://www.sigmaaldrich.com/united-kingdom.html
(MSDS links can be found on individual product pages)

BOC website provides general information on gas safety:
http://www.boconline.co.uk/health/gas_safety/index.asp

APPENDIX 1: Toxic Gases

The location of each cylinder of toxic gas should be recorded and this information held by the Departmental Safety Officer or other designated person. The keeper of records should be notified immediately of any change in the location of a cylinder. This will enable users to locate cylinders without delay, will minimise the possibility of deterioration of cylinders of corrosive substances which might otherwise be stored and forgotten, and will provide essential information for the emergency services.

Toxic gases should be stored and used only in Departmentally agreed locations having appropriate facilities.

No work with toxic gases should be carried out until agreement has been reached on procedures/precautions and until the intention to use the gas has been notified to the designated person in the Department and to other workers in the vicinity.

A list of toxic gases is shown below. Toxic gases which are not on this list but which may be used in departments should be subject to the same rules. Some of these substances may be prepared *in situ* for use in reactions. On completion of the Risks Assessment form, local decisions should be made on the necessary precautions and need for notification, depending on the scale and circumstances of use.

Boron trifuloride
Carbon monoxide
Carbonyl fluoride
Chlorine
Chlorine trifluoride
Cyanogen
Fluorine
Hydrogen chloride
Hydrogen bromide
Hydrogen fluoride*
Hydrogen iodide
Hydrogen sulphide
Hydrogen cyanideVinyl fluoride
Iodine pentafluoride
Nickel carbonyl
Nitric oxide
Nitrogen dioxide (dinitorgen tetraoxide)
Nitrogen trifluoride
Nitrogen trioxide
Nitrosyl chloride
Phosgene
Phosphorus pentafluoride
Silicon tetrafluoride
Sulphonyl fluoride
Tetrafluorohydrazine
Vinyl chloride

* Separate Guidance Notes covering HF are available from the University Director of Safety Services

Note:
All compressed gases deserve special attention. Departments must have clear rules for safe handling, safe storage, the use of correct cylinder heads, pressure reduction heads, adapters, flame arresters, tubing and connectors, and protective traps to prevent suck-back. Under no circumstances should cylinders be freestanding. The BOC website provides more information on general gas safety http://www.boconline.co.uk/health/gas_safety/index.asp

FOR SAFETY ADVICE IN AN EMERGENCY INCIDENT INVOLVING CYLINDERS OR STORAGE VESSELS:

BOC Gases 24 hour helpline 0800 111 333

APPENDIX 2: Red List Substances

This is a Schedule of dangerous substances which **must not** be put down the drains.

3-Chlorotoluene
Aldrin
Altrazine
Azinphos-methyl
Cadmium and its Compounds
Carbon Tetrachloride
Chloroprene
DDT
Dichloroethane 1.2
Dichlorvos
Dieldrin
Endosulfan
Endrin
Fenitrothion
Gamma-Hexachlorocyclohexane (Lindane)
Hexachlorobenzene (HCB)
Hexachlorobutadiene (HCBD)
Malathion
Mercury and its Compounds
Pentachlorophenol (PCP)
Polychlorinated biphenyls (PCBs)
Simazine
Tributyltin compounds
Trichlorobenzene
Trifluralin
Triphenyltin compounds

Appendix 3: Examples of Substances Requiring Special Care in Disposal to Drains

This list was drawn up by the Severn-Trent Water Authority with materials liable to be present in larger-scale effluents from industrial and commercial premises in mind and must be interpreted with discretion.
The range of substances with hazardous properties that is in use in the University is more extensive, and the disposal of such substances must be undertaken with the same care.

Mineral acids and alkalis
Metals and their compounds: Iron, Aluminium, Antimony, Arsenic, Beryllium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Vanadium, Zinc
Cyanides or compounds containing cyanide
Salts including: Nitriles, chlorates, fluorides, sulphates, hypochlorites, nitrates, nitrites, perchlorates, sulphides, sulphites, carbides
Phenols, cresols and simple derivatives
Tar and tar oils
Mineral oils, oil emulsions, grease
Ammonia or ammoniacal compounds
Paint wastes
Pharmaceuticals including steroids and hormones
Surface active agents
Organosilicon compounds
Acrylonitrile
Formaldehyde
Carbohydrates, yeast
Cooling water, boiler blowdown, scrubbing water
Organohalogen compounds (e.g. pesticides and degreasing agents) not included in the 'Red List'
Organosulphur compounds not included in the 'Red List'
Any other substance known to be toxic or hazardous to the environment.

Appendix 4: Partial List of Incompatible Chemicals (Toxic Hazards)

Substances in the left hand column should be stored and handled so they cannot possible accidentally contact corresponding substances in the centre column, because toxic materials (right hand column) would be produced.

Arsenical materials	Any reducing agent*	Arsine
Azides	Acids	Hydrogen azide
Cyanides	Acids	Hydrogen cyanide
Hypochlorites	Acids	Chlorine or hypochlorous acid
Nitrates	Sulfuric acid	Nitrogen dioxide
Nitric acid	Copper, brass, any heavy metals	Nitrogen dioxide (nitrous fumes)
Nitrites	Acids	Nitrous fumes
Phosphorus	Caustic alkalis or reducing agents	Phosphine
Selenides	Reducing agents	Hydrogen selenide
Sulfides	Acids	Hydrogen sulphide
Tellurides	Reducing agents	Hydrogen telluride

Appendix 5: Partial List of Incompatible Chemicals (Reactive Hazards)

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

Acetic acid	Chromic acid, nitric acid, peroxides and permanganates
Acetic anhydride	Hydroxyl-containing compounds, ethylene glycol, perchloric acid
Acetone	Concentrated nitric and sulphuric acid mixtures, hydrogen peroxide
Acetylene	Chlorine, bromide, copper, silver, fluorine and mercury
Alkali and alkaline earth metals such as sodium, potassium, lithium, magnesium, calcium	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)
Aluminium powder	Halogenated or oxygenated solvents
Ammonia, anhydrous	Mercury, chlorine, calcium hypochlorite, iodine, bromine and hydrogen fluoride
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrates, sulphur, finely divided organics or combustibles
Aniline	Nitric acid, hydrogen peroxide
Bromine	Ammonia, acetylene, butadiene, butane and other petroleum gases, sodium carbide, turpentine, benzene and finely divided metals
Calcium oxide	Water
Carbon, activated	Calcium hypochlorite
Chlorates	Ammonium salts, acids, metal powders, phosphorus, sulphur, finely divided organics or combustibles
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, phosphorus, sulphur, finely divided organics or combustibles
Chlorine	Ammonia, acetylene, butadiene, butane, other petroleum gases, hydrogen, sodium carbide, turpentine, benzene and finely divided metals
Chlorine dioxide	Ammonia, methane, phosphine and hydrogen sulphide
Copper	Acetylene, hydrogen peroxide
Fluorine	Isolate from everything
Hydrazine	Hydrogen peroxide, nitric acid, any other oxidant and heavy metal salts
Hydrocarbons (benzene, butane, propane, gasoline, turpentine etc)	Fluorine, chlorine, bromine, chromic acid, conc. Nitric acid, peroxides
Hydrogen cyanide	Nitric acid, alkalis
Hydrogen fluoride	Ammonia, aqueous or anhydrous
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, any flammable liquid, combustible materials, aniline, nitromethane
Hydrogen sulphide	Fuming nitric acid, oxidising gases
Iodine	Acetylene, ammonia (anhydrous or aqueous)
Mercury	Acetylene, fulminic acid*, ammonia
Nitric acid (conc.)	Acetic acid, acetone, alcohol, aniline, chromic acid, hydrogen cyanide, hydrogen sulphide, flammable liquids, flammable gases, nitratable substances, fats, grease

Nitromethane, lower nitroalkanes	Inorganic bases, amines, halogens, 13X molecular sieve
Oxalic acid	Silver, mercury, urea
Oxygen	Oils, grease, hydrogen, flammable liquids, solids or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils, dehydrating agents
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphinates	Any oxidant
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 nitrate	Ammonium nitrate and other ammonium salts
Sodium peroxide	Any oxidizable substance, such as ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfuric Sulphuric acid	Chlorates, perchlorates, permanganates
Thiocyanates	Metal nitrates, nitrites, oxidants
Trifluoromethane sulfonic acid	Perchlorate salts

* - Produced in nitric-ethanol mixtures.

Appendix 6: Explosive Chemicals

The following may be supplied as laboratory reagents, pharmaceuticals, or polymer components. However, they are in fact explosives. Appropriate care should be taken in storage and disposal, especially if they have deteriorated in any way.

Acetylene
Acetyl peroxide
Ammonium nitrate
Ammonium picrate
Benzoyl peroxide
Cumene peroxide
Dinitrophenylhydrazine
Dipicrylamine
Dipicryl sulphide
Ethylene oxide
Lauric peroxide
Methyl ethyl ketone peroxide
Nitrogen trifluoride
Nitroglycerin
Nitroguanidine
Nitromethane
Picramide
Picric acid
Picryl chloride
Picryl sulphonic acid
Propargyl bromide
Succinic peroxide
Trinitroanisole
Trinitrobenzene
Trinitrobenzene sulphonic acid
Trinitrobenzoic acid
Trinitrocresol
Trinitronaphthalene
Trinitrophenol
Trinitroresorcinol
Trinitrotoluene
Urea nitrate

Appendix 7: Deteriorated Chemicals

The following is a selection of chemical substances, which can deteriorate to a dangerous condition with age, under common storage conditions. The degree of the hazard will vary considerably with age and exact situation, but it is advisable to take precautions when discarding, recycling or otherwise handling old samples. The numbers in brackets correspond to the key below the table.

Acetal (3)
Acetaldehyde diethyl acetal (3)
2-Acetyl furan (3)
Acetyl peroxide (1)
Aluminium chloride (5)
Aluminium lithium hydride (5)
Ammonia solution (5)
Ammonium dichromate (4)
Ammonium hydroxide (5)
Ammonium persulphate (5)
Anethole (3)
Anisaldehyde (3)
Anisole (3)
Anisyl chloride (5)
Aqua regia (5)
Benzenesulphonyl chloride (5)
Benzoyl peroxide (1)
Bleach (5)
Bleaching powder (5)
2-(2-Butoxyethoxy) ethyl acetate (3)
2-Butoxyethyl acetate (3)
t-Butyl hydroperoxide (4)
iso-Butyl ether (2)
n-Butyl ether (3)
n-Butyl glycidyl ether (3)
Calcium carbide (5)
Calcium hydride (5)
Calcium hypochlorite (5)
Cellosolve (3)
Chloroform (5)
Chromic acid (5)
Chromium trioxide (4)
Cleaning mixtures (5)
Cumene (3)
Cumene hydroperoxide (5)
Cyclohexene (3)
Cyclopentadiene (3)
Cyclopentene (3)
Decahydronaphthalene (3)
Decalin (3)
Di-allyl ether (3)
Di-iso-amyl ether (3)
Dibenzyl ether (3)
Di-iso-butyl ether (3)
Di-n-butyl ether (3)

Dicyclopentadiene (3)
1,1-Diethoxyethane (3)
Diethylacetal (3)
Diethyl azidoformate (4)
Diethyl azodicarboxylate (1)
Diethylene glycol dimethyl ether (3)
Diethyl ether (3)
Diglyme (3)
Dihydropyran (3)
1,2-Dimethoxyethane (3)
Dimethoxymethane (3)
Dimethylamine (5)
2,4-Dinitrophenol (1)
2,4-Dinitrophenylydrazine (1)
1,4-Dioxan (3)
Diphenyl ether (3)
Di-iso-propyl ether (2)
Di-n-propyl ether (3)
Ether (3)
Ethyl cellosolve (3)
Ethylene glycol dimethyl ether (3)
Ethylene glycol ethyl ether acetate (3)
Ethylene glycol monobutyl ether (3)
Ethylene glycol monoethyl ether (3)
Ethylene glycol monomethyl ether (3)
Ethyl ether (3)
-Ethoxyethanol (3)
-Ethoxyethyl acetate (3)
Ethyl vinyl ether (2)
Furan (3)
Glycidyl n-butyl ether (3)
Glyme (3)
Hydrogen peroxide (5)
Iodine pentoxide (4)
Isoamyl ether (3)
Isobutyl ether (2)
Isopentyl ether (3)
Isopropyl alcohol (3)
Isopropyl ether (2)
Isopropyl benzene (3)
Lauroyl peroxide (5)
Lithium aluminium hydride (5)
Lithium hydride (5)
Magnesium perchlorate (4)
Mercury fulminate (1)

2-Methoxyethanol (3)
Methylal (3)
Methyl cellosolve (3)
Methyl iso-butyl ketone (3)
Methyl ethyl ketone peroxide (1)
Methyl vinyl ketone (3)
Nitric acid (5)
Nitromethane (1)
Nitrosoguanidine (5)
Peracetic acid (1,4,5)
Perchloric acid (4)
Phosphorus trichloride (5)
Picric acid (1)
Picryl chloride (1)
Picryl sulphonic acid (1)
Potassium (metal) (1)
Potassium amide (1)
Potassium chlorate (4)
Potassium perchlorate (4)
Potassium persulphate (5)
Propan-2-ol (3)
Propargyl bromide (1)
Propargyl chloride (1)
Silicon tetrachloride (5)
Silvering solution (1)
Sodamide (1)
Sodium amide (1)
Sodium borohydride (5)
Sodium chlorate (4)
Sodium chlorite (4)
Sodium dithionite (5)
Sodium hydride (5)
Sodium hydrosulphite (5)
Sodium hypochlorite (5)
Sodium metal dispersions (1)
Sodium perchlorate (4)
Sodium peroxide (5)
Sodium persulphate (5)
Styrene (3)
Tetrahydrofuran (3)
Tetralin (3)
Thionyl chloride (5)
Trinitrobenzene (1)
Trinitrobenzene sulphonic acid (1)
Urea nitrate (4)
Urea peroxide (5)
Vinyl acetate (3)
Vinylidene chloride (1)
Vinyl pyridine (3)
Zinc (5)

(1) Can deteriorate to a shock-sensitive explosive. Take exceptional care if there is evidence of drying out, crystillization or contamination. It may be very dangerous to attempt to open the container.

(2) Forms peroxides, especially on exposure to air and light, making the material liable to explode. This class is so dangerous that it should not normally be distilled unless it has been very well controlled. Material more than one year old should be discarded, even if unopened. Containers should not be opened if there is ant solid visible around the closure or any evidence of crystals inside.

(3) Also forms peroxides. If very old or obviously in poor condition treat as (2). Otherwise take care to test for peroxides before use or recovery procedures.

(4) High energy materials which are sensitive to the presence of dust. Clean the outside of containers before opening. If in doubt, do not open. Mixtures of the material with dust, paper or organics may ignite or detonate when exposed to friction, e.g. on the threads of a screw-capped container.

(5) Containers may have a high internal gas pressure, owing to decomposition. Open carefully behind a safety shield in a fume cupboard.
(N.B. A high internal pressure can also result from biological decay, radioactive decay or corrosion of metal containers.)