SCHOOL OF PHYSICS

SAFETY MANUAL

All staff and employees are to read Chapters 1 to 8 inclusive upon issue of this Manual or upon joining the School thereafter. Other sections should be consulted before starting any of the activities with which they deal. Any amendments made following routine or exceptional reviews will be promulgated upon their incorporation.

Everyone has a duty to ensure that s/he is working in a safe manner and to bring to the attention of their immediate supervisor or their Safety representative any dangerous or unsafe practices or circumstances.

Please take an interest in the regulations, instructions and advice contained within this Manual. Suggestions to improve health, safety and welfare are welcome and will be included in updated issues as appropriate.

Tim NAYLOR
Norman Lockyer Professor of Astrophysics
Head of School 1 Nov 08

1. SCHOOL OF PHYSICS HEALTH & SAFETY POLICY STATEMENT

The School

The School of Physics (the School) is committed to the provision of a healthy and safe workplace and work environment for all employees, students, contractors, visitors, and members of the general public who may be affected by the work of the School.

The Head of School recognises and accepts this responsibility, and undertakes so far as is reasonably practicable to:

- Ensure the Health, Safety and welfare of employees whilst they are at work, and other persons who may be affected by the work of the School.
- Comply with the Health and Safety at Work Act (1974) together with other relevant legislation and legal requirements.
- Provide the necessary resources to ensure that proper provision is made for health, safety and welfare.
- Regularly monitor the workplace and work activities to ensure the effectiveness of the Health and Safety policy and to ensure that safe systems of work exist and are followed by employees, students and visitors.
- Liaise with Buildings and Estates so that the University may provide and maintain the premises and all items of plant, equipment and machinery ensuring systems of work that are safe and without risks to health.
- Where applicable, provide and maintain appropriate and sufficient personal protective equipment and health monitoring devices.
- Provide such training, information, instruction and supervision for new and existing employees so as to ensure their health and safety whilst at work, together with the health and safety of others who may be affected by their actions.
- Carry out risk assessments, maintain records and review and revise as necessary in accordance with the legal requirements.
- Provide and maintain First Aid services adequate to the School's operations.
- Maintain statutory measures for fire prevention and liaise with Buildings and Estates so that suitable, sufficient and adequate fire fighting equipment is supplied with appropriate systems and protocols employed for emergency evacuation.

- Consult with employees and their representatives on matters relating to health and safety.

- Maintain records of, and take appropriate action as a result of, all accidents and incidents.

- Ensure that adequate provision is made for the proper use, handling, storage and transportation of articles and substances so that they are safe and without risk to health.

- Provide health surveillance to personnel where appropriate.

To achieve the above statement the Head of School will:

- Appoint a School Safety Officer and other nominated staff with specific Health and Safety duties as appropriate.

- Maintain a consultative Safety Group to administer safety matters, set safety targets, co-ordinate safety inspections, and monitor safety performance within the School, in consultation with University Health and Safety Officers as appropriate.

- Ensure all levels of management are aware of their Health and Safety responsibilities and their obligations to provide and maintain as far as is reasonable practical, safe systems of work.

- Ensure all employees understand their individual statutory duties under relevant legislation so securing as far as is reasonably practicable the Health, Safety and Welfare of themselves and other persons with whom they are in contact at work.

- Establish and maintain lines of communication throughout the School, consulting with employees as and when required to secure their co-operation and aid the effective monitoring of safety matters.

- Maintain a proactive attitude regarding safety criteria when consideration is given to refurbishing existing or planning new premises.

- Review this policy on a regular basis to ensure that legal compliance with new or existing legislation is maintained, in consultation with University Health and Safety Officers as appropriate.

Staff and students

Supervisory staff are responsible for statutory compliance in their areas of responsibility. This involves identifying and ensuring compliance with safe schemes of work, and includes responsibility for the safety of students in their laboratory/area, and for ensuring that aall Postgraduate students and new research staff under their supervision have attended general induction and appropriate further safety training.

All other staff have a duty to take reasonable care for the health and safety of themselves and others who may be affected by their actions and omissions. They have a duty to comply with relevant regulations and the School's arrangements for Health and Safety.

The School has a duty of care towards students and they are offered the same health and safety protection as employees. In return, students also have a duty to take reasonable care for the health and safety of themselves and others who may be affected by their actions and omissions, and students are required to comply with the School's arrangements for Health and Safety.

Research students must consult their academic supervisors about all their practical work in order that the potential hazards may be assessed and suitable safety precautions taken. Further discussion with appropriate Safety Officers or Advisers, or the Head of School may be necessary for some experiments.

All staff and students have a duty to ensure that they are working in a safe manner, and to bring to the attention of their immediate supervisor, Safety Officer or representative, any matter or practice they consider to be dangerous or unsafe. All have a duty to attend Health and Safety mandated training provided by the University and/or the School.

Risk Assessment

The essence of Health and Safety policy is that all work procedures which expose any person to a significant hazard are to be assessed for risk and appropriate control measures adopted. Upon identifying a hazard, there should be a written and recorded risk assessment which concludes by identifying a safe system of work. This is covered in detail within the University's Guidance Notes for the Management of Health and Safety At Work which includes a risk assessment form for general use. Specific procedures and forms are introduced for particular circumstances, such as handling substances hazardous to health (Control of Substances Hazardous to Health (COSHH) procedures), in managing work where this is risk of radiation, for manual handling tasks, and for work associated with lasers. All University policies, codes of practice, guidance notes and risk assessment forms can be obtained via the documentation page of the Health, Safety and Environment Office website.

All persons carrying out a risk assessment must be satisfied that they have sufficient expertise and experience to be able to recognize potential hazards. **It is the person undertaking the work/procedure who has the responsibility to ensure that this is the case before starting work. In the case of students, the assessment of risk should be done by the supervisor and the students must be made aware of all the potential hazards and the detailed requirements of the safe system of work**.

Contractors and Visitors

The School is committed to ensuring the Health, Safety and Welfare of contractors and visitors whilst they are on the School's premises. Any restricted areas will be clearly defined and where necessary restraints (e.g. barriers) installed. All School employees have a responsibility to ensure such areas are respected. Authorised contractors coming on to the premises will be advised by the School of its Health and Safety policy but it is the responsibility of the contractor to ensure that their employees are fully aware of the contents of the Safety Manual as it affects them in their work. All contractors must supply the School with a copy of their Health and Safety policy, scheme of work and other relevant statutory registers or documentation if requested.

School Safety Organisation

The Vice Chancellor together with the Registrar and Secretary of the University has executive responsibility for safety in the University. The University Health and Safety Policy outlines these responsibilities. The University Health and Safety Officer and assistants advise members of the University on safety matters. The Head of the School of Physics has executive responsibility within the School, and delegates the implementation of regulations to staff with specific responsibility in certain areas; the School Safety Officer, the Director of Building, the School Radiation Protection Officer, the School Laser Safety Officer, Laser Safety Supervisors, Radiation Protection Supervisors, and general supervisory staff.

Terms of reference for (H&S) for the Head of School, Director of Building and School Safety Officer are contained within the University Health and Safety Policy. Terms of reference for the School Laser Safety Officer, and Laser Safety Supervisors are contained within University of Exeter Local Rules for the use of Lasers and the Association of University Radiation Protection Officers "Guidance on the Safe Use of Lasers in Education and Research". Terms of reference for the School Radiation Protection Officer and Radiation Protection Supervisors are contained within University of Exeter Use of Radiation and Radionuclides Codes of Practice and Guidance Notes.

School Safety Group

The School Safety Group is an advisory group set up in order to promote an effective safety culture within the School and provide the guidance to ensure a safe working environment iaw relevant legislation and University safety policies and procedures, by:

- monitoring incidents and accidents and advising the Head of School on safety issues arising, in consultation with University Health and Safety Officers as appropriate
- maintaining appropriate Health and Safety documentation
- ensuring adequate training is provided to new joiners
- reviewing risk assessments and conducting safety inspections to assure that hazards have been properly identified and appropriate control measures implemented to minimise risk
- providing points of contact for staff to seek advice in specific areas of Health and Safety

The Group is comprised of the following staff with their functions as shown, and meets once per term to enable report to the School meeting and Management Committee.

Mr D Colridge, School Electrical Adviser
Dr H Dehghani, School Radiation Protection Officer
Mrs E Green, School COSHH Adviser
Mr D Jarvis, School Safety Officer
Mr D Manning, School Cryogenic Safety Adviser
Dr J Moger, School Laser Safety Officer
Professor T Naylor, Head of School

Mr S Trotter, School Manager and Director of Building
Mr S Tuckett, School Workshop Supervisor

Mr Colridge and Mrs Green are also Radiation Protection Supervisors for Teaching Laboratories and Biomedical Physics respectively. Additionally, Mrs L Barrell, Mr R Edge and Mr M Wears are qualified First Aiders within the School.

2. PAN UNIVERSITY AND OTHER GENERAL POLICIES, REGULATIONS AND GUIDANCE

University Health and Safety Policy

This document specifies the overall objectives to comply with all statutory Health and Safety requirements, adopt all other reasonably practicable means to eliminate hazards and reduce the risk of injury to its employees, students, visitors, contractors and members of the public, and the risk of damage to property. It makes reference to relevant statutory provisions and describes the organisation within the University for policy making, provision of advice, monitoring of Health and Safety, and executive responsibility. Finally, it outlines the arrangements in place to carry out statutory Health and Safety duties. Appendices to the document contain the following further information:

Appendix A – List of Policy Statements, Codes of Practice and Guidance Notes on individual health and safety issues that the University has prepared or is preparing:

Appendix B – Statements of relevant statutory provisions related to the University, and covering:

The Health and Safety at Work, etc (1974) Act

EEC based UK legislation – the so called 6-pack of:
Management of Health and Safety at Work Regulations (1992, 1999)
Health and Safety (Display Screen Equipment) Regulations (1992)
Manual Handling Operations Regulations (1992)
Provision and Use of Work Equipment Regulations (PUWER, 1992, 1998)
Personal Protective Equipment at Work Regulations (PPE, 1992)
Workplace Health, Safety and Welfare Regulations (1992)

Other H&S legislation as follows:
Occupiers Liability Act (1957)
Factories Act (1961)
Offices, Shops and Railways Premises Act (1963)
Fire Precautions Act (1971)
Health and Safety (First Aid) Regulations (1981)
Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR, 1995)
Control of Substances Hazardous to Health Regulations (COSHH, 1988, 1994, 1999)
Noise at Work Regulations (1989)
Electricity at Work Regulations (1989)
Environmental Protection Act (1990)
Food Safety Act (1990)

Appendix C – List of staff with health and safety responsibilities for policy making, advising and monitoring

Appendix D – List of staff with executive responsibilities for health and safety

Appendix E – Form to record personal details for use in cases of emergency

Appendix F – Emergency procedures for accidents involving injury

Appendix G – Emergency procedures in case of fire

Specific University Policy Statements and Guidance

The following University Policies, Codes of Practice and Guidance Notes can be found via the documentation on the Health and Safety website:

The Management of Health and Safety at Work (Regulations, 1999) Guidance Notes and Risk Assessment Form
Control of Substances Hazardous to Health - Policy, Code of Practice and Guidance Notes and Assessment Form
Ionising Radiation Safety Guidance Notes, Monthly Returns Form, Usage and Disposal Sheet (and guidance notes)

Laser Guidance Notes
Association of University Radiation Protection Officers Guidance on the safe use of lasers in education and research
Use of Radiation and Radionuclides - Codes of Practice and Guidance Notes
Manual Handling Operations - Guidance Notes and Assessment Form
Portable Electrical Appliance Inspection and Testing Policy - Code of Practice and Guidance Notes
Fire Safety Policy, Code of Practice and Guidance Notes
Meningitis Policy and Code of Practice
Staff use of private vehicles on University business – Policy and Code of Practice
Minibus Passenger Transport Vehicles Policy, Code of Practice and Guidance Notes
Children, Young People and Vulnerable Adults on Campus - Policy, Code of Practice and Guidance Notes
Smoking Policy

Further Regulations

Lifting Operations and Lifting Equipment Regulations (LOLER 1998)
Petroleum Consolidation Act (1928)
Abrasive Wheels Regulations (1970)
Woodworking Machines Regulations (1974)
Pressure Systems and Transportation of Gas Containers Regulations (1989)
Chemicals (Hazard Information and Packaging for Supply) Regulations (1994)
Control of Asbestos at Work Regulations (2002)
Safety Representatives and Safety Committee Regulations (1977
Radioactive Substances Act (1960 and 1993)
Ionising Radiations Regulations (IRR, 1999)
Genetic Modification (Contained Use) Regulations (2000)
Mines and Quarries Act (1954)
The Construction (Health, Safety & Welfare) Regulations (1996)
Construction (Design and Management) Regulations (1994)
Construction (working Places) Regulations (1966)
Health and Safety (Training for Employment) Regulations (1990)
Health and Safety (Dangerous Pathogens) Regulations (1981)
The Poisons Act (1972)
Poisons Rules (1982)
Petroleum Consolidation Act (1928)

Further Information

Further information is available from the University Health and Safety Office, including.

UCEA Code of Practice 2001
UCEA Safety in Fieldwork
UCEA Health and Safety Guidelines for Working Overseas
UCEA Stress Management
UCEA Health and Safety Guidance – Placements of HE Students
CRC Handbook of Laboratory Safety
RSC Safe Practices in Laboratories

Useful websites include:

http://www.ucea.ac.uk/index.cfm/pcms/site.Publications.Health_and_Safety/
http://www.hse.gov.uk
http://physchem.ox.ac.uk/MSDS/

The University also has a limited site license for the Barbour Index Health and Safety Documentation Service – details on how to log into the system are available from the University Health and Safety Office.

3. RISK ASSESSMENT

The proper assessment of risks and the implementation of suitable precautions to reduce those risks is the basis of most health and safety regulations. Risk assessment is required by all safety regulations (e.g. Management of Health and Safety at Work Act, Manual Handling regulations, Control of Substances Hazardous to Health (COSHH) Regulations, etc) such that employers are required to make a suitable and sufficient assessment of:

- the risks to the health and safety of their employees to which they are exposed while at work, and
- the risks to the health and safety of persons not in their employment arising out of or in connection with the conduct by the employers or of their undertaking

A *hazard* is something which has the potential to cause harm to people, or damage to equipment, buildings or the environment. A *risk* is a function of the likelihood of that harm or damage actually occurring and the severity of its consequences.

A Risk Assessment must consider:

- What is the hazard?
- What could go wrong?
- Where is there likely to be a problem?
- Who might be hurt?
- Why might it happen?
- When could it happen?
- How could all this be avoided?

Risk assessments must be reviewed periodically, and following any changes to procedures etc.

The School Safety Group will review selected risk assessments to assure that hazards have been properly identified and the appropriate control measures are in place to minimise risk.

4. GENERAL SAFETY

General

All staff, visiting workers and students are required to contribute to health and safety in the School of Physics by working in a manner that is clean, tidy and thoughtful at all times and by ensuring that all work procedures have been subject to risk assessment. The following general safety points apply.

- There must be no eating, drinking, smoking in laboratories or workshops.
- Fire doors must never be jammed open
- Where appropriate and required, suitable protective clothing must be worn but must not be taken into rest areas and coffee rooms. Laboratory coats should be hung up separately from other clothing.
- All staff should be aware that, for example, open shoes or shorts are inappropriate for certain types of activity. There may be occasions when long hair should be tied up.
- Safety spectacles or visors must be worn when handling acids, alkalis, corrosive or other hazardous materials and when using workshop machinery.
- Suitable gloves should be worn when handling hazardous materials, including liquid cryogens.
- Where used, disposable gloves should be changed frequently to avoid contamination. Remove disposable gloves before handling other equipment and books and before leaving the appropriate work area/laboratory if possible. To avoid contamination, one glove must always be removed to handle doorknobs etc.
- Corridors and room exits should be kept clear at all times. Clothes and belongings should be kept in cloakrooms, lockers or designated areas in the laboratory/ workshops areas where applicable.
- Do not run in corridors.
- Trolleys or appropriate carriers should be used to convey equipment, materials and chemicals.
- Care should be taken when using glassware, in particular when fitting rubber/plastic connections and using pipettes.
- Do not work with flammable solvents near a naked flame, or place them in refrigerators or freezers unless these are spark-proofed.
- Mobile phones must be turned off particularly when working with flammable solvents.
- The presence of children in laboratories is not permitted. If it is necessary for a child to enter the building, this is permitted if the child is at all times supervised by a responsible adult and is not left unattended. All responsibility for accidents caused will be that of the parent or person in charge of the child.
- Pets must not be brought into the School's premises.
- Vaccination against tetanus is strongly recommended (available from your GP).

Permits to work

For both safety and insurance purposes, service engineers and members of the Buildings and Estates Division must obtain a permit to work before commencing work in any laboratory, and must be warned of any hazards associated with the area. These permits also ensure that the workers are covered by the University insurance. Equipment for repair should be clean and free from hazards before they commence work. The University Asbestos Register is available from Buildings and Estates.

Access to roof areas

The person responsible for issuing work permits for work within the building is the School Safety Officer. Responsibility for issuing permits for work outside the building including work on the tower block roof and/or slab block roof rests with Buildings and Estates. However, responsibility for control of personnel to these roof areas rests with the School Safety Officer who is to ensure that risk assessments have been completed, and safe systems of work are established. This remains true for access to the observatory on the slab block roof by authorised staff and students.

Observatory safety

Working at night in proximity to moving equipment is potentially hazardous, and safety is the primary concern when observing. Each observing session is overseen by a member of academic staff or a postgraduate demonstrator, who is designated as the Night Officer, and students may never observe on their own. Specific rules apply to ensure observatory safety.

Students working in Research Laboratories

No Undergraduate or Postgraduate student may carry out experimental work in a research laboratory or student workshops until (s)he has received appropriate induction safety briefing, read the relevant risk assessment(s) and signed to that effect in locally held records of safety briefings.

No rapidly toxic materials may be handled by Undergraduates working in the research laboratories unless his/her supervisor or other member of staff is present.

Out of Hours Working including Lone Working Out of Hours

Lone working in laboratories out of normal University hours is not permitted for undergraduate students.

Postgraduate research students may only undertake experimental work outside normal working hours if permission has been obtained from their academic supervisor who has considered the safety aspects of their work.

Permission must be sought from the Head of School by anyone wishing to undertake practical work in laboratories involving hazardous materials or techniques outside normal working hours, or work with hand tools or machinery in the workshops outside normal working hours. Approval will only be granted when arrangements are made to ensure another responsible person is present and remains in sight of the person conducting the work, and to ensure that this person will not undertake any hazardous activity him/herself and is familiar with the safety procedures involved with the work.

Anyone working outside normal working hours must sign his or her name and times of arrival and departure on the record held in the foyer at the rear entrance to the Physics Building. This is for security reasons and to ensure that in case of fire or other emergency that a record of people in the building is readily available.

For all cases of non-hazardous lone working, it is always best practice to try to ensure that another responsible person is always within calling distance.

Recharging of Low Temperature Apparatus

If it is not possible for a research group to arrange for two research workers to be present when the topping up of refrigerants is required, the following procedure should be arranged with Patrol HQ:

Telephone Patrol HQ on internal Ext 3999 to advise:

a. That the recharging procedure is about to take place.
b. The approximate time before a further call will be made to confirm that the exercise has been completed.
c. The internal extension number to be contacted if no further call is made and also two external phone numbers which can be contacted in case of emergency (e.g. Supervisor's home phone number).

If confirmation is not received after the due period has elapsed, Patrol HQ should try to establish contact on the internal phone number given, whilst directing a patrolman to investigate. If an emergency develops the external phone numbers will be used to contact specialised help without delay.

Unattended Operation of Experimental Apparatus

All personnel in the Physics Department who need to leave apparatus running unattended must discuss arrangements and relevant risk assessment with the School Safety Officer, and complete a temporary running permit. This permit may be valid for up to 14 days. A new permit is required for each new unattended experiment or renewal past 14 days.

The permit is invalid unless correctly completed and signed by the responsible supervisor. Apparatus left running unattended must have the appropriate permit displayed in a prominent position adjacent to it with a copy displayed on the laboratory door together with a notice indicating that the apparatus is running outside normal working hours. A further copy of the permit must be passed to the School Safety Officer who must maintain a record of all extant permits.

- The description of the apparatus, gases, chemicals and/or micro-organisms in use, the name of worker and supervisor must be completed, together with emergency telephone numbers and signature of supervisor.
- If the equipment requires running water, then all hoses must be secured and checked daily; remember that the water pressure tends to increase at night.

It is in your interest to complete these forms as the Estate Patrol or other workers may turn off equipment found without appropriate permits.

Equipment Left Running Permanently

Each laboratory must list all equipment left running permanently. A master list must be held centrally by the School Safety Officer and reviewed annually. A permanent running permit will be issued for each item.

- Electrical equipment must have a current electrical safety test and have a plug marked orange.
- Only essential equipment such as incubators, refrigerators etc, should be left running permanently.
- Contact telephone numbers should be supplied for each item of equipment.

Solvents (see also Section 8)

Common solvents have a low boiling point, higher vapour pressure and low surface tension. This may lead to the risk of fire and explosion as well as being a toxic hazard (see notes on important points relating to common chemicals). Flammable liquids should not be poured from one vessel to another or heated near an open flame. The 'no smoking' rule must be rigidly observed at all times. Solvents will only be issued in small quantities in a labelled container. Excess solvent should be returned to stores or to special disposal containers (metal containers with screw stoppers) as soon as possible. The containers must be kept tightly stoppered and stored outside where practicable. Solvents must never be poured down the sink.

Use of Flammable Gases

(eg carbon monoxide, butane, propane, ethylene, acetylene, methane, calor gas, town gas, hydrogen).

Where any of these gases are used "No smoking or Naked flames" notices must be permanently displayed and enforced during the period of the activity/experiment. Care should always be taken to minimise electrical arcing or frictional sparks in the vicinity, and also the quantity of flammable materials. In the case of a large leakage of flammable gas/vapour, the person in charge must ensure that the area of work is ventilated thoroughly before electricity is turned on or off. Tubes used for conducting hydrocarbon gases should not be of rubber, as this is softened by them, but of PVC, neoprene, metal or polythene.

It is often required to pass flammable gases through a cold trap to remove water vapour or other contaminants. When this is done, the following rules should be observed

- When using a system where metallic contamination is already present, a trap made of stainless steel or aluminium alloy should be used. A trap so constructed is not subject to cracking from thermal shock.
- If high purity levels have to be maintained, a silica or glass trap may be used but only with liquid Nitrogen as coolant. The reason is that if the trap were to crack and a high leak rate ensued the liquid air or oxygen could mix with the gas and cause a dangerous explosion.
- When using the apparatus, the whole should be thoroughly flushed through with the gas before the trap is placed in the coolant, so as to avoid condensation of residual air, an obvious hazard.
- A cold trap is frequently the greatest single volume in a piece of apparatus, therefore representing the greatest explosive potential; it is a good point to fit a rupture bubble to the trap so that the pressure can find relief without smashing the trap, and so creating a flying gas hazard.

Room ventilation

Room ventilation systems are the responsibility of Buildings and Estates Department. Checks are made as prescribed by them. Any faults or inefficiencies that are suspected should be reported to the appropriate Laboratory Supervisor or School Safety Officer. In case of emergency, the Buildings and Estates Division should be contacted directly and the School Safety Officer advised.

Lift Breakdown Procedure

In case of lift breakdown the Porter should be contacted (ext 3933) or the Estate Patrol directly (ext 3999). A trapped person pressing the warning button inside the car informs Estate Patrol HQ in Northcote House that a lift in an identified building has broken down. On receiving this signal a Patrol Supervisor alerts lift service engineers who will take appropriate action to have the passengers released as quickly as possible.

No attempt should be made to rescue passengers yourself if any are trapped inside the car.

5. EMERGENCY PROCEDURES

Action in the event of Fire

If you discover a fire in the building firstly:

- Sound the alarm

Then, if the fire is small and can be safely tackled without taking personal risk, attack the fire with fire fighting equipment available. Turn off gas and electricity supplies. Use a CO2 or dry powder extinguisher for electrical fires. Continue to shout for help. If you extinguish the fire proceed directly to the main entrance foyer and report the incident.

Alternatively, if the fire is large and out of control:

- Leave immediately, closing the door behind you.
- Do not stop to collect personal belongings.
- Call the Fire Brigade
  - Dial 999 from the nearest safe telephone
  - Notify Estate Patrol by dialing 3999 on an internal or 263999 on an exchange line
  - Give the address which is Physics Building, Stocker Road, Exeter EX4 4QL
- Make your way out of the building to the Fire Assembly Point (do not use the lifts)
- Report to the Fire Safety Officer (at the Assembly Point or main entrance) to provide details on precise location and nature of the fire

If you hear the alarm:

- Close your door and windows
- Do not stop to collect personal belongings
- If you have responsibility for a colleague with special needs, contact that person and give assistance
- Make your way out of the building to the Fire Assembly Point (do not use the lifts)
- Do not re-enter the building until told it is safe to do so

The Fire Assembly Point for Physics building is across the road opposite the main entrance and further up the hill towards the Sports Centre. Fire alarms are tested every week on Wednesday mornings. Ignore the bell if it rings at this time, unless it rings continuously for more than 2 minutes, when the drill above should be carried out. A fire drill is carried out at the beginning of the first term in the academic year during an afternoon when the building is at its busiest. This aims to ensure that new students are aware of the correct procedure whilst also noting the time required for complete evacuation of the building, which should be less than 5 minutes.

Whenever a fire extinguisher is used, the facts of the incident must be reported immediately to the Safety Officer. The extinguisher must be returned for checking and refilling.

Fire Marshalls are appointed to assist in evacuating the building.

Bomb Warnings

If informed of a bomb in the building by the Police or a caller:

Immediately sound the fire alarm to evacuate the building.
If informed by a caller, call the Police (999) and then call the Estate Patrol (ext 3999)

Move outside the building, initially to the Fire Assembly Point to await and co-operate fully with further instructions from the Police.
Be prepared to move well clear of the building and vehicles parked in the vicinity (bomb blasts can be dangerous up to 200 metres away)

If informed of a bomb somewhere in the University immediately call the Police and then the Estate Patrol. Do not evacuate the building but await further instructions.

Major Accidents

In the event of a major accident, immediate action should be taken as follows

- Determine continuing danger and extent of injury
- If necessary, evacuate area,
- Summon help & ensure that the following are contacted:
  - the emergency services (999, any phone)
  - a First Aider (where available)
  - the Estate Patrol (263999 or Ext 3999)

If safe to do so, ensure that the injured are accompanied until help arrives.
Thereafter, as soon as possible:

- Ensure that the following are informed:
  - the Health, Safety and Environmental Office (3049)
  - the Head of School / Director of Building
  - the School Safety Officer
  - a Trade Union Health and Safety representative
  - PERSONNEL DIVISION (3120)
- Record the accident details on a University Accident Report Form (see below)

Minor Accidents

In the event of a minor accident, immediate action should be to:

- Determine continuing danger and extent of injury
- Summon help & ensure that:
  - a First Aider (where available) is contacted
  - the injured are accompanied until help arrives
- As soon as possible thereafter ensure that accident details are recorded on a University Accident Report Form (see below)

Accident report forms

Most accidents in the School are caused by slips, trips and falls, minor cuts by sharp objects or by lifting heavy or awkward objects. All accidents, however trivial, must be reported immediately

to the immediate supervisor and also the School Safety Officer. Any and all accident details are to be reported on a University Accident Report Form available on the intranet via the documentation page of the Health, Safety and Environment Office website or from the School Safety Officer or School Office. The original of this form must be sent to the H&S office with a copy to the School Safety Officer.

First Aid

First aid equipment is available throughout the building. Whenever first aid equipment is used an accident form should be filled in with a coy forwarded to the School Safety Officer. A list of trained first aiders is posted on Notice Boards at various sites throughout the School, to ensure that all staff are aware of the location of their nearest First Aider. These qualified First Aiders should always be contacted in the event of an accident.

If it is clear that the patient requires further treatment but can be moved in a car he or she should, after initial first aid action has been taken, be taken to the RD&E Hospital (Wonford), tel 411611. If the patient requires an ambulance contact the Emergency Services and ask for an ambulance, and also alert the Estate Patrol. For any eye injuries or foreign bodies in eye, take the patient to the RD&E Wonford (eye casualty, tel 402399). If a person is ill or simply needs to lie down and rest, take him/her to the University First Aid Room (Ground Floor, Peter Harrison Building). In cases of poisoning, dial 999 and ask for an ambulance and inform the Emergency Services of the nature of the case.

Outside working hours, for all serious injuries that occur in these times dial 999 and ask for an ambulance. Minor accidents should be dealt with and reported the following morning. If in any doubt or difficulty contact Estate Patrol (3999)

Student Health Centre

Students should register with a doctor as soon as they arrive in Exeter either at the University Health Centre at Reed Mews on the Streatham campus, at the St. Luke's Health Centre, or with a nearby practice. The University's Principal Medical Officer, or one of the other doctors located at the University Health Centre are available for consultation by appointment during term time on weekdays from 9.00 am to 12.30 pm and from 2.00 pm to 4.30 pm. An emergency only service on Saturday mornings is available between the hours of 10.00 am to 10.30 am. A limited service is available during vacation periods. St Luke's Campus Health Centre, is located at South Cloisters. Further information is available from the Student Guild.

In Case of Emergency Forms

In Case of Emergency forms are provided for your voluntary use if you wish information to be recorded that may greatly assist the Emergency Services and also allow your next-of-kin to be quickly informed of any emergency that has involved you directly. The form is available via the documentation page of the Health, Safety and Environment Office website – specifically Appendix E to the health and safety policy. Completed forms should be forwarded to the School Secretary and will be kept safe and treated with the strictest confidence.

6. ELECTRICAL SAFETY

General

Building and Estates are responsible for carrying out 5 year mandatory periodic electrical testing of all permanent electrical installations. Anyone who carries out live work must receive special training in the techniques involved. No one should work on live equipment unaccompanied and live work must be carried out in accordance with approved procedures. Before work commences adequate screening of adjacent live conductors and earthed metal work is imperative. Full use should be made of properly insulated tools, rubber mats and rubber gloves. Low voltage (<250V) and medium voltage (<650V) apparatus should be worked upon with the apparatus dead if practicable. Maintenance of high voltage apparatus must be carried out with the apparatus completely isolated.

Electrical Hazards and Elementary Precautions

Voltages above 50 volts AC and 120 volts DC are hazardous and can be fatal. Fatal accidents have occurred in unfavourable circumstances with only a 40V supply. The hazards arising from the use of electrical apparatus are the risks of electric shock, burns, fire and explosion, injury from involuntary reaction to otherwise harmless shock, and in the microwave and ultraviolet range, radiation damage. If batteries etc are used for low voltage supplies the terminals and connections should be protected to avoid the danger of a short-circuit and hence burns arising from conductors which may accidentally fall on the battery. Electric shock can cause cardiac arrest or cessation of breathing, either of which can be fatal.

Burns can occur externally or internally. External burns can be caused by the passage of an electric current through the skin or as a result of an electric arc or a short circuit. Burns resulting from short circuits are often made worse by pieces of molten metal, from vaporised conductors, embedding in the skin. Internal burns are caused by the passage of electric current through blood vessels and internal organs.

The main causes of such accidents are the use of defective or broken equipment, faulty connections, wrongly sized fuses and the utilisation of wiring of inadequate load bearing capacity. If you are in any doubt concerning any of these features in connection with any electric installation on which you work, you should consult your Supervisor or School Electrical Adviser. Under no circumstances should you use electrical apparatus about which you have any doubt over safety.

It is usual to safeguard against electrical shock by ensuring that external metal casings of all apparatus or equipment is earthed, and so to fasten such a casing or screen that it is impossible to touch any electrically 'live' parts of the apparatus. With correctly earthed supply installations, the use of well designed and correctly earthed commercial equipment, the risk of electric shock should be nil. It is important to realise that certain modern items of equipment, particularly power drills are not earthed through the casings, but rely on efficient double insulation. Under no circumstances, therefore, should the eternal casings of these items be interfered with. Items with defective, especially cracked casings, should not be used but returned to a competent electrician for repair.

Electrical equipment which is often moved and which subjects the plug to hard wear e.g. portable electric drills, soldering irons etc should have plugs of the shock resistant type. Do not, for example, allow leads to pass under water baths.

On some equipment of foreign origin the plugs are not fused. If in doubt consult the School Electrical Adviser.

The continuity of earth connections on portable equipment must be checked periodically (see PAT testing). If any normally earthed equipment must be left unearthed for some specific purpose, a notice should be attached which makes this quite evident to any unsuspecting person.

Flexible rubber leaders should be kept away from hot surfaces and where connections have to be made in hot locations the cables should be suitably protected.

Particular care is needed when electrical equipment is used near water. Outlets should be situated as far away as possible from sinks and care should be taken to ensure that water from condenser tubing, water baths etc does not leak onto electrical installations and equipment.

The maintenance of equipment and wiring is a high priority. Any suspected fault should be reported to the School Safety Officer immediately.

- All staff and students are expected to be vigilant about the safe condition and operation of equipment.
- The use of extension leads and multisockets is discouraged.
- The use of privately owned equipment/appliances and extensions leads is discouraged. Such equipment must undergo testing before use. This equipment should be entered in the School inventory for insurance and audit purposes. The University insurance will only cover such equipment that is directly required for work, non-authorised equipment is the responsibility of the owner and he/she is personally liable for any damage, accident, injury or death resulting from its use.
- Plug tops with suitably rated fuse should normally be fitted by qualified technicians only.

- Faults to permanent wiring and 13A sockets etc, must be notified to the Laboratory Superintendent or School Safety Officer. The fault must be made safe by switching off the supply to the immediate area if possible.
- Special care must be taken when using electrical equipment in the vicinity of flammable vapours. Precautions must be taken to ensure the equipment is spark-proofed. This especially applies to fridges and freezers.
- Staff and students are expected to operate equipment in a safe manner.
- Earth leakage circuit breakers or RCCBs should be used when equipment is operated under adverse conditions eg. in damp or cold areas; seek advice from the School Electrical Adviser.
- Supervisors should risk-assess new equipment and apparatus built in-house; taking into account instructions and safety data that come with relevant components. Such equipment should be safety assessed and checked for fitness for purpose by supervisors and signed accordingly. If supervisors do not feel qualified to assess this, then advice should be sought from the School Electrical Adviser or other suitably qualified person.

Repair of Equipment

Repairs of equipment must only be carried out by the qualified technicians. Faulty equipment should be reported to the School Safety Officer, who will arrange for the repair.

On no account should research workers attempt electrical repairs of any type including the replacement of 13 amp plugs. Any item of electrical equipment which is considered faulty or in need of any minor repair MUST be handed to the technician in charge of the laboratory.

Electrical Safety Testing of Equipment (PAT)

Under the Electricity at Work Regulations 1989 all electrical equipment and appliances used within the School must be tested at recommended intervals. The technician responsible for the laboratory carries this out. A green label will be attached to the equipment stating date of test and when the next test is due. Test frequency is as follows:

- Every 6 months for high risk equipment eg. portable hand tools
- Every 12 months for portable laboratory equipment
- Every 2 years for large laboratory equipment
- Every 3 years for IT equipment

Check all equipment that you use has a valid electrical test label before use. The technician responsible for the laboratory should be informed immediately of any equipment that is out of test date. Do not use such equipment.

Any item that has failed the PA test or is faulty should be labelled accordingly and taken out of service immediately.

7. MECHANICAL SAFETY

Lifting Equipment

There is a statutory requirement for the periodic testing of lifting equipment. The School Safety Officer must be informed of all such equipment brought into the School. No mechanical lifting is to be undertaken by anyone other than those members of staff specifically qualified to do so, who are responsible for conducting the operation safely.

Mechanical Hazards

Personal Protective Equipment (PPE). Suitable PPE must be worn at all times where risk assessment dictates. Goggles must be worn for any operation which is hazardous or potentially hazardous to the eyes. Goggles are recommended particularly for use when working with bromine or volatile bromine compounds, strong ammonia, any irritating dust, acids and alkalis. They should also be used when making fusions or cutting sodium, breaking up solidified melts, chipping any hard materials, opening cylinders containing gas under pressure, when using grinding apparatus, and when carrying out any operation with a danger of liquid splashing.

Centrifuges**.** Centrifuges can be very easily damaged and are a source of danger when improperly used. At 5,000 rpm, the periphery of a 10 cm radius rotor is travelling at over 110 mph: never try to stop a centrifuge with the hand. The load on a centrifuge should always be balanced accurately before switching on to avoid putting undue stress on the bearings. Centrifuges should be kept scrupulously clean as corrosion can seriously weaken the rotor. Only centrifuges specifically designed for low temperature work should be kept in cold rooms.

Vacuum Systems. Although much vacuum apparatus is constructed of glass, it is worthwhile remembering that an increasing range of equipment made of plastic is now available, including vacuum desiccators. Unsuitable glassware, e.g. conical flasks other than thick-walled Buchner flasks should never be even partially evacuated. Considerable damage can be caused by the collapse of large glass vessels. They should be exhausted behind safety screens. Do not use a large vessel if a small one will do.

When vacuum apparatus is assembled. The equipment should always be examined for stresses and strains, both before and after filling, (a kilogram of reagents, e.g. 75 mls mercury, can introduce severe strains in glass apparatus). Any glass vessel that is seriously scratched should be discarded. Sudden changes of temperature should be avoided and the vessel should be placed on a rubber mat, or even surface, to avoid any irregular pressure on the base.

Metal or plastic tubing should be used wherever possible, and flexible items, e.g. bellows couplings, should be included in the apparatus. Where ground glass unions are used, ball and socket joints are to be preferred to cone and socket joints.

As far as possible, vacuum apparatus should be screened. Equipment should be prominently labelled when left under vacuum. The risk of implosion with wide bore tubing, bulbs and items up to about 1 litre capacity can be reduced by strapping with cloth adhesive tape, cellophane tape, or varnished cloth mesh. Larger items should be encased in a stout gauge wire screen. Where such precautions are impracticable the entire apparatus should be placed behind Perspex or stout wire screens. It is a wise precaution to wear safety goggles when operating glass vacuum apparatus.

It is important to ensure that rubber bungs are large enough to resist being sucked into a vacuum vessel. Stopcocks should always be properly lubricated, operated slowly and never forced.

There is serious risk of implosion (and consequently a flying glass hazard) with certain commercially available equipment. Dewars, for example, the large vessels present as considerable hazard. With these implosion is most likely as a result of careless handling. Thermal shock is produced while filling the vessel with liquefied gas, and allowing it to evaporate before filling. All Dewar vessels should be in a protective case or at least made shatter-proof by plastic adhesive tape stuck on the outside. Vacuum tubes of all kinds should be handled with care. Because of their size the hazard is particularly great with cathode ray tubes, and special care should be taken not to scratch any part of the bulb, especially the face.

Vacuum desiccators and bell jars are frequently treated with contempt. These should always be screened and never moved whilst under vacuum. They should always be labelled if left evacuated.

High Pressure Systems (Including Autoclaves)

Most of the safety precautions required for vacuum work apply to high pressure apparatus but the following points also apply.

Pressure vessels should be examined by a competent person at least once every period of 26 months or at such intervals as the competent person dictates. The safe working pressure of each vessel should be marked on it and any pressure relieving safety devices that are fitted should be so designed as to ensure that in the event of equipment failure leading to a rapid rise in temperature within the pressure vessel under test, the safe working pressure will not be exceeded. If it is not possible to achieve this standard of safety protection then the whole apparatus must be encased within an enclosure of such strength as will be able to resist the effect of explosion of the pressure vessel.

Safety valves and other methods of pressure release should be sited so as to minimise the chance of injury to people or damage to equipment if they should operate.

Great care should be taken to use only materials and equipment designed to withstand high pressures, e.g. seamless tubing etc. Regular inspections should be made to discover blocked filters, leaking valves, weld crack etc. If glass apparatus is to be pressurised it should be screened and safety goggles worn by the operator.

At very high pressures, serious accidents have occurred due to unexpected chemical reactions taking place and producing much higher pressure than those for which the apparatus was designed.

Some commercially available light sources, e.g. the xenon arc lamps used in spectrofluorometers are filled under very high pressures. Such lamps should never be handled without safety goggles.

Workshop hazards

The principal hazards in workshops include injuries caused by moving parts, failure of equipment, incorrect or careless use of hand tools, faulty or damaged tools, etc. Many accidents in this category can be avoided merely by the correct use of equipment that is well maintained and inspected. In general, the wearing of rings, necklaces and bracelets is discouraged and for some work, their removal will be required.

All machines, whether hand or power operated should be fitted with appropriate guards or other safety devices. These should always be used. Protective clothing, appropriate to the work in hand, should always be worn and long hair should be tied back and protected by suitable head gear.

Only qualified technicians or staff/students acting under the supervision of suitably qualified technicians as authorised by the Workshops Supervisor may use the workshops facilities.

Welding

Welding should always be carried out in well ventilated booths since toxic gases can be generated at the high temperatures involved. Special care is necessary with painted or plated metals. Appropriate eye protection should be worn by anyone working in or visiting a welding booth while work is in progress. Only technicians trained and qualified in welding procedures and associated safety precautions are authorized to operate the School's welding equipment.

8. CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH (COSHH)

COSHH procedures

The Control of Substances Hazardous to Health Regulations 1988, 1994, 1999 & 2002 are designed to protect workers or others against substances considered hazardous to health in the workplace. COSHH assessments must be completed for any process or procedure that involves the use of hazardous substances. Hazardous substances may be found in nearly all working environments. Their effects may include the following and others:

- Poisoning through ingestion, inhalation or skin absorption, for instance, losing consciousness or death as a result of being overcome by toxic fumes
- Eye irritation or loss of sight from eye contact
- Skin irritation or dermatitis from skin contact
- Asthma as a result of developing an allergy to substances used at work
- Cancer or other mutagenic effects, which may appear long after the exposure to the chemical that caused it
- Infection from bacteria and other micro-organisms

Before carrying out a procedure with hazardous materials (including micro-organisms) any risk must be identified and assessed. It is the responsibility of the Supervisor and the laboratory worker to jointly assess the hazards associated with their work. Except in the very low risk situations it will be necessary for the assessment to be in the written form using a COSHH assessment pro forma. The process assessor and the process supervisor must sign the assessment form.

The process supervisor may delegate the task of assessment but s/he cannot delegate the supervisory responsibility. The process supervisor has executive control of and health and safety responsibility for the process and s/he must ensure that the assessment is complete and appropriate then sign it. The main findings of this assessment must be recorded in writing and then reviewed if there has been a significant change in the work. **It is mandatory, BEFORE work is commenced, that the assessment is recorded and a copy is held locally in laboratory master records of COSHH assessments.**

The School Safety Group will review selected COSHH assessments to assure that hazards have been properly identified and the appropriate control measures are in place to minimise risk.

The forms are available from the School COSHH Adviser or from the documents page of the University Health and Safety website.

COSHH procedures require the following steps are taken in the assessment**,** carried out by the person with the most knowledge and experience of the process, i.e. the process assessor. The assessor should carry this out jointly with the process supervisor.

Step 1. Identify the hazardous substances used or created by your procedure. What is the hazardous substance? Is it:

- Substances or mixtures of substances classified as dangerous by the *Chemicals (Hazard Information and Packaging for Supply) Regulations 1994 (as amended) (CHIP).* These substances can usually be identified by their hazard-warning label and should have a material safety data sheet.
- Substances with occupational exposure limits (OEL). These are published in the HSE *Occupational exposure limits* publication EH40 available in the Safety Office.
- Biological agents and other micro-organisms directly connected with work.
- Any kind of dust in a concentration specified by COSHH.
- Any other substance, which has comparable hazards to people's health, but which for technical reasons, may not have a hazard label eg some pesticides, medicines etc.

There are a number of other materials that are not actually covered by COSHH, such as asbestos, radioactive materials, lead and scheduled materials: these are covered by their own regulations. However, an assessment must be conducted.

Step 2 Consider the risk these substances present to people's health. Assessing the risk involves making a judgement of how likely it is that a hazardous substance will affect someone's health. How much of the substance is used? How could people be exposed to it? Who could be exposed to the substance and how often?

Step 3 If you identify significant risks then decide what precautions are needed to remove or reduce those risks to an acceptable level. What control measures are required? What are the first aid measures in case of an accident? What are the disposal methods?

Step 4 Ensure that control measures are used and maintained so that exposure to hazardous material is prevented or adequately controlled. This may involve changing the process so that the hazardous material is not needed or replacing it with a safer form. If prevention is not practical then the control measures must be improved so that exposure is adequately controlled and *OELs* are not exceeded.

Workers should be properly informed, trained and supervised. For certain very hazardous materials, exposure must be monitored and there should be health surveillance, the use of these materials is not permitted without prior consultation with the School Safety Officer. Any control measures that are used must be maintained and tested eg the fume cupboards are tested and serviced by Buildings and Estates Division. Defects must be reported to the School Safety Officer.

Chemicals

Bottles. All bottles of chemicals must be clearly and correctly labelled, and only those chemicals in use or likely to be required in the near future should be kept in the research laboratories. Over-labelling of original manufacturers labels is forbidden. Labelling must not be liable to facile removal eg on spillage of contents or splashing with solvent/water.

Mercaptans/Thiols. The School is obliged to report the use of such chemicals to other areas of the campus to avoid confusion over possible gas leaks. On any occasion, before handling mercaptans/thiols, workers must report their intention to the School Safety Officer.

Handling of Potentially Hazardous Air/Moisture-sensitive Compounds. Any research worker intending to use a potentially hazardous air/moisture-sensitive compound (eg organolithium reagents) must discuss the appropriate techniques for safe handling with their supervisor and fill out a COSHH Assessment form before starting the work. A copy of the Aldrich Technical Bulletin AL-134 “Handling Air-sensitive Reagents” must be consulted.

Rapidly toxic materials. May only be handled in the presence of at least one other experienced worker.

Inorganic Cyanides. Inorganic cyanides are controlled substances and will only be issued on presentation of a fully completed COSHH assessment form, which has been signed by the Research Supervisor and the School Safety Officer. A cyanide antidote kit must be obtained for the duration of the work. Only the required amount for the risk-assessed reaction is obtainable and residues must be destroyed immediately after use. Records of use must be kept.

S1 poisons and other controlled substances. The use of poisons, controlled substances and other forensic products under Schedule 1, 2, 3 and 4 are controlled through the Home Office. Many can only be obtained using special ordering procedures. Scheduled substances may only be ordered by academic staff, post doctoral research personnel and certain trained technical staff. All scheduled substances must be stored under lock and key and records of use must be kept. Their use must be subject to risk assessment as above. Some examples of S1 Poisons and Red list of proscribed substances are:

Arsenic and its compounds (except those containing less than 0.0075% As)

Aldrin	Atrazine
Azinphos-methyl	Bromomethane
Cadmium and its compounds	Carbon Tetrachloride
Dieldrin	DDT
Dichlorvas	1,2-Dichloroethane
Endosurfan	Endrin
Fenitrothion	Fluoroacetic acid and its salts
Hydrogen cyanide and cyanide salts	gamma-Hexachlorocyclohexane
Hexachlorobenzene	Hexachlorobutadiene
Mercury and its compounds	Malathion
Nicotine and its salts	Pentachlorophenol
Polychlorinated Biphenyls	Simazine
Trichlorobenzene	Tributyltin compounds
Triphenyltin	Trifluralin

EC regulation on Drug Precursors. Under 2005 EC regulations the purchase of certain drug precursor chemicals requires a licence. The use of these materials must be recorded and a return must be completed for the Home Office. Further details are available from the School COSHH Adviser.

Chemical Weapons Convention. Under the Chemical Weapons Convention, the importation, use and production of certain chemicals and precursors must be recorded. There are restrictions on placing orders for these chemicals. Further details are available from the School COSHH Adviser.

Working with Insects or other Livestock. Persons working with insects are at risk of developing allergic reactions. These reactions can be skin rashes, itchy eyes, and runny nose but if severe may lead to more serious conditions such as asthma. Suitable precautions must be taken to reduce these risks including the use of facemasks conforming to FFP2. A COSHH assessment must be carried out.

Micro-organisms. Micro-organism, cell culture, or human endoparasite, including any which have been genetically modified, which may cause any infection, allergy, toxicity or otherwise

create a hazard to human health must be assessed under COSHH. Such materials are also subject to the rules on handling micro-organisms.

Solvents

Laboratory workers must be aware of the hazard associated with solvents; many are highly flammable and toxic and therefore should also be assessed under COSHH.

- Most solvents are very volatile and so may easily be inhaled and will often cause drowsiness even if they are not toxic. Some can cause irritation or dermatitis if spilt on the skin.
- Solvents should be stored in flameproof cabinets containing metal trays capable of retaining at least 110 per cent of the contents of the largest container stored. Large quantities must not be stored in the open laboratory. No more than 50 litres of highly flammable liquids may be stored in any one place.
- Flammable and non-flammable solvents should not be stored together.
- Flammable solvents should not be stored in refrigerators or freezers unless these have been spark-proofed.
- Never put solvents for disposal down the sink.
- As there is a real possibility of explosion of waste acetone and chloroform in the presence of alkali, ACETONE should only be added to the blue labelled waste bottles; if for some reason it is contaminated, then it should be sent for disposal in a separate container clearly labelled 'Do not mix with other waste solvent'. Waste solvent should be separated into bottles of:
    - Acetone
    - Halogenated waste solvent (Chloroform, dichloromethane etc) and
    - Non-halogenated waste solvent (ethanol, ether etc)

- Winchesters of solvents should be transported around the building using the carriers available for them and not carried in the hand.
- Winchesters must not be left on the floor, on top of shelves or on reagent bottle shelves and they should not be kept on bench working surfaces for longer than necessary.
- In general, waste solvent which contains a high concentration of acid or base should not be indiscriminately added to general waste solvent containers but disposed of separately.
- Decompose reactive materials before placing in waste solvent bottles.

Cryogenics

- A cryogenic fluid is normally defined as one which is manufactured, stored, handled or processed at temperatures at or below 188 K (-85°).
- Liquid nitrogen, helium and other cryogenics including solid CO2 must only be stored or conveyed in approved Dewar containers. Sealed containers must never be used due to build-up of dangerous pressure.
- Care should be taken when handling cryogenic liquid storage Dewars. Avoid mechanical shock and damage to the vessel's vacuum insulating jacket. Breakdown of the insulation will cause rapid boil-off of the liquid contents, producing large quantities of gas and a possible increase in pressure within the vessel.

- Liquid helium Dewars should not be tilted.
- Dewars should only be used for the specific liquids for which they are designed.
- Persons transferring liquid nitrogen and other cryogenics from storage containers to liquid nitrogen refrigerators or Dewar flasks (including small vacuum flasks) must use facemasks or goggles, and suitable gloves.
- Dry gloves should always be worn when handling anything that is or may have been in contact with cold liquids or vapour. Gloves should be a loose fit so that they are readily removed should liquid splash on to them or into them.
- Attention is drawn to the need for adequate ventilation when using liquid nitrogen and other cryogenics including solid CO2. Never remain in a small enclosed space or travel in a lift with a Dewar of liquid nitrogen or other cryogenic material. Such area should be fitted with an oxygen depletion monitor. Liquid nitrogen and helium, although non-toxic, produce large quantities of gas which can cause an oxygen deficient atmosphere and asphyxiation.
- Open transfers of cryogenic liquids and venting or purging operations should be carried out in well ventilated areas.
- Exposure of the skin to low temperature can produce effects on the skin similar to a burn. Naked or insufficiently protected parts of the body coming into contact with very cold uninsulated pipes or vessels may stick fast by virtue of the freezing of the available moisture and the flesh may be torn on removal. Protective clothing for the handling of low temperature liquefied gas serves mainly to protect against frost burns.
- Prolonged exposure to cold can result in frostbite. Prolonged inhalation of cold vapour or gas can damage the lungs. Cryogenic liquids and vapour can damage the eyes.
- The low viscosity of cryogenic liquids means that they will penetrate woven or other porous materials much faster than for example water.

Compressed gases and gas cylinders

It is recommended that compressed gas should be sited outside buildings and distributed to points of use by means of fixed piped systems where this is reasonably practicable. The very minimum of flexible couplings should be used at each end. A suitable location for the cylinders should be chosen in a well-ventilated position remote from sources of ignitions, sources of fire-hazard (e.g. storage of flammable material) and building openings, the cylinders being safely supported, physically protected and the manifolds of good engineering design.

The number of cylinders inside laboratories should be kept to the smallest reasonably practicable number. Spare cylinders should be kept in the storage compound.

Only qualified technicians are authorized to handle compressed gas cylinders. Correct handling procedures are important to avoid damage to cylinders or injury to personnel. After being moved and before being put into use, it is important to carry out routine checks that the identification markings on cylinders are correct, the cylinders are safely installed and that the valves, regulators and other ancillary equipment are intact.

One of the main dangers is over-pressurisation of the cylinder in the event of a fire. This is particularly so when the gas has liquefied under pressure. Cylinders should be stored away from any source of heat such as boilers etc and should always be sited at a safe distance from other high fire risks.

The hose and hose connections are the weakest links in the system and failure of these is a known cause of fire and explosions. So far as is practicable gases should be distributed through

suitable fixed metallic pipework. When flexible gas pipes are necessary they should be suitable for the duty intended and preferably be of metal or metal armoured type. Pipes should be as short as reasonably practicable and protected from possible physical heat or corrosion damage. Flexible hoses should be replaced periodically in accordance with the manufacturer's advice.

The following general points apply.

- Toxic or asphyxiant gases such as CO2 can build up in confined spaces.
- Compressed gas cylinders are colour coded according to the gas contained. Cylinders containing flammable gases are red or part red and have a left-handed thread; non-flammable gas cylinders have a right hand thread for fitting of regulators.
- Gas regulators should be fitted by trained personnel only, training must be provided for new research workers before they change cylinder regulators.
- Never over-tighten regulators when fitting and do not lubricate threads,
- Cylinder colours, valve threads or markings, should never be interfered with.
- Cylinders must be stored or used upright and strapped to a secure support away from heat.
- Cylinders should only be moved using the appropriate equipment. Safety shoes and cylinder trolleys are to be used, available from stores. Laboratory workers are required to move gas cylinders; qualified technicians will assist or advise when available.
- Regulators should only be used for the gas identified on the regulator.
- Gases which assist fire, eg oxygen, should be stored separately to flammable gases.
- The door to the laboratory should be labelled with the gases in use to inform fire fighters in the event of a fire.
- Cylinders not in regular use should be returned to the stores.

Personal Protective Equipment (PPE)

Research workers must make full use of the safety equipment available and have the requisite items at hand before commencing a potentially dangerous experiment.

PPE refers to equipment such as clothing, respirators, helmets, ear protectors, safety boots and eye protectors and gloves required for use in hazardous situations. PPE such as ear protection and filter respirators should be considered as the "last resort" once all other measures to reduce a risk to acceptable levels have been taken. Doing the job by a safer method should always be considered first. PPE must be suitable for the risks involved and must be maintained (including cleaned) in an efficient state and working order. Under the latest COSHH regulations, filter respirators must be tested for face fit.

Ensure that the appropriate type of disposable glove is worn for a given application – for example nitrile gloves may not be the best choice for many organic solvents.

When working with micro-organisms, a laboratory coat with side fastenings is recommended. This coat must be kept separate from other lab coats and outside clothing.

Eye protection must be chosen that is appropriate to the risk, visors should be used when handling large quantities of corrosive or hazardous materials but safety spectacles may be used for small quantities. Eye protection to BS EN 170 is suitable for use when there is a risk of UV radiation.

British and new European standards cover the specification for PPE in given situations.

Prevention of Fire and Explosion – general comments

The major risk of fire and explosion in laboratories is caused by the use of unsuitable equipment in explosive atmospheres or in areas where quantities of flammable vapour are present. In such an environment, it is essential that non-sparking or spark-proof apparatus is employed and that apparatus with moving parts should not be run in such a manner as to overheat. If such a fire should arise, switch off the apparatus and use the appropriate extinguisher, i.e. a CO_2 extinguisher or dry powder extinguisher if a fire involves solvents. Under no circumstances should water or foam extinguishers be used.

Apparatus containing heating elements used for heating liquids etc should not be allowed to overheat and should remain covered by the liquid. It is preferable, where possible, to use the modern type of fail-safe connection with an ejector plug or fusible link.

Do not use immersion heaters of water-type for heating baths of fluids other than water.

To reduce fire hazard, stocks of flammables in laboratories should be kept to a minimum. If materials requiring special fire-fighting materials are stored in the laboratory, a suitable notice showing the correct fire-fighting instructions should be displayed on the door of the laboratory.

Definitions. The flash point is the temperature at which a substance gives rise to an ignitable vapour. If a substance is cooled below its flash point, the danger of ignition through the vapour reaching nearby flames, cigarettes, sparks or hot surfaces is much reduced. The minimum ignition temperature is that at which the vapour will spontaneously catch fire in air. Thus if vapour from a liquid at room temperature is carried by a draught into contact with a surface at a temperature above the ignition temperature the vapour may ignite and burn back to ignite the liquid. The minimum ignition energy of a flammable mixture of given composition and at a specific temperature and pressure id that below which ignition cannot be produced: operation below this level is the underlying principle of intrinsically safe equipment.

Toxic and Injurious Chemicals – General Comments

All chemical, especially organic substances, should be regarded as potentially hazardous unless they are known to be otherwise. Many substances which are not obviously corrosive or toxic can act as cumulative poisons. Most chemicals can be handled by simple methods provided that a little common sense is used. However, the well known action of dusts, vapours and oils in causing lung, skin and other diseases must be kept in mind. A surprisingly large number of substances are capable of causing diseases to develop after a period of apparent immunity e.g. asbestosis, cancer.

Care should be taken to avoid inhalation of vapours, ingestion of liquids and solids, and all unnecessary contact with the skin. Easting a drinking, smoking, application of cosmetics and sucking pencils can all lead to accidental ingestion or skin absorption. The prime preventive against accidental contamination is good housekeeping. Use of fume cupboards, and the wearing suitable protective equipment including goggles should always be used wherever appropriate to minimise the risk to personnel.

Chemical Storage hazards

Chemicals should be stored in such a way as to minimise the risk of accidental contact between incompatible chemicals, which could arise from breakage, spillage or fire. The table below provides a list (not exhaustive) of chemicals that need to be segregated on the grounds of potential reactive or toxic hazard. It is the responsibility of those working with chemicals to ensure they have assessed these risks and have stored all chemicals appropriately.

Ideally, fume cupboards should never be used for the storage of chemicals due to the very real risk of spillage. It must always be remembered that a fume cupboard is a working environment and those located in the Biophysics laboratory are a School resource – ensure your safety and the safety of others by not storing chemicals in these fume cupboards. Occasionally however, the storage of material in fume cupboards may be unavoidable, but if the chemicals must be in clearly labelled containers, with all potential hazards clearly indicated and with all containers placed in a tray in order to contain any accidental spillage.

Poorly labelled samples and chemicals pose an unacceptable risk to everyone and will NOT be tolerated.

List of reactive chemical hazards

(NOTE: this list is NOT complete, indicative only; it is YOUR responsibility to check reactive hazard risks)

The substances in the left hand column must be stored and handled so that they can not accidentally come into contact with the corresponding substances in the right hand column under uncontrolled conditions because violent reactions may occur. IT IS ESSENTIAL THESE CHEMICALS ARE SEGREGATED IN ORDER TO MINIMISE THE RISK OF ACCIDENTAL CONTACT

SUBSTANCE	**AVOID ACCIDENTAL CONTACT WITH, AND KEEP SEGREGATED FROM:**
ACETIC ACID	Chromic acid, nitric acid, hydroxyl containing compounds, ethylene glycol, perchloric acid, peroxides and permanganates
ACETONE	Conc. nitric acid and sulphuric acid mixtures
ACETYLENE	Chlorine, bromine, copper, silver, fluorine and mercury
AlKALI and ALKALI EARTH metals	Carbon dioxide, carbon tetrachloride, other chlorinated hydrocarbons. IMPORTANT NOTE: DO NOT use water, foam or dry chemical on fires involving these metals, extinguish with dry sand
AMMONIA (anhyd.)	Mercury, chlorine, calcium hypochlorite, iodine, bromine and 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 and 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 and other flammable liquids
CHLORINE	Ammonia, acetylene, butabiene, butane and other petroleum gases, sodium carbide, turpentine, benzene and finely divided metals,
CHLORINE DIOXIDE	Ammonia, methane, phosphine and hydrogen sulfide
COPPER	Acetylene, hydrogen peroxide
FLUORINE	ISOLATE FROM EVERYTHING
HYDRAZENE	Hydrogen peroxide, nitric acid and any other oxidant
HYDROGEN CYANIDE	Nitric acid, alkalies
HYDROGEN FLUORIDE (anhyd.)	Ammonia aqueous or anhydrous
HYDROGEN PEROXIDE	Copper. Chromium, iron, most metals and metal salts, any flammable liquid, combustible materials, aniline, nitromethane
HYDROGEN SULFIDE	Conc. Nitric acid, oxidising gases
IODINE	Acetylene, ammonia (aqueous or anhyd.)
MERCURY	Acetylene, fulminic acid, ammonia
NITRIC ACID conc.	Acetic acid, acetone, alcohol, aniline, chromic acid, HCN, hydrogen sulphide, flammable liquids and nitratable substances
NITROPARAFFINS ($CH_3CH_{2n}NO_2$)	Inorganic bases peroxides and 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.
PEROXIDES (ORGANIC)	Acids (organic or mineral) NOTE: avoid friction when handling also store at low temperature
PHOSPHORUS (WHITE)	Air, oxygen
POTASSIUM CHLORATE	Acids, ammonium salts metal powders, sulphur finely divided organics and combustible materials
POTASSIUM PERMANGANATE	Glycerol, ethylene glycol, benzaldehyde, sulphuric acid
SILVER	Acetylene, oxalic acid, tartaric acid, fulminic acid, ammonium compounds
SODIUM NITRITE	Ammonium nitrate and other ammonium salts
SODIUM PEROXIDE	ANY oxidisable substance, such as ethanol, methanol, glacial acetic acid, acetic anhydride benzaldehyde, glycerol, ethylene, ethyl acetate etc…
SULPHURIC ACID	Chlorates, perchlorates, permanganates

Toxic chemical hazards

Listed below are some chemicals which, if they come into contact will produce a toxic hazard. NOTE: this list is not exhaustive and very much a partial list to act as a guide for common

hazards. It is YOUR responsibility to ensure you understand and minimise the risk of the accidental production of toxic products.

The substances in the left hand column should be store and handled with care so that they cannot possibly accidentally contact the corresponding substance in the centre column, because otherwise toxic materials (in the right hand column) would be evolved.

SUBSTANCE	**AVOID ACCIDENTAL CONTACT WITH:**	**TOXIC PRODUCT IN CASE OF CONTACT**
ARSENICAL MATERIALS	ANY REDUCING AGENT	ARSINE
AZIDES	ACIDS	HYDROGEN AZIDE
CYANIDES	ACIDS	HYDROGEN CYANIDE
HYPOCHLORITES	ACIDS	CHLORINE or HYPOCHLOROUS ACID
NITRATES	SULPHURIC ACID	NITROGEN DIOXIDE
NITRIC ACID	COPPER, BRASS, ANY HEAVY METALS	NITROGEN DIOXIDE (NITROUS FUMES)
NITRITES	ACIDS	NITROUS FUMES
PHOSPHOROUS	CAUSTIC ALKALIES or REDUCING AGENTS	PHOSPHINE
SELENIDES	REDUCING AGENTS	HYDROGEN SELENIDE
SULFIDES	ACIDS	HYDROGEN SULFIDE
TELLURIDES	REDUCING AGENTS	HYDROGEN TELLURIDE

9. DISPOSAL PROCEDURES

General

Flammable substances and water immiscible substances must not be discharges down sinks. In addition, the following substances must not be poured down the sink (the Red List of proscribed substances):

Mercury and its compounds	Cadmium and its compounds	gamma-Hexachlorocyclohexane
DDT	Pentachlorophenol	Hexachlorobenzene
Hexachlorobutadiene	Aldrin	Dieldrin
Endrin	Carbon Tetrachloride	Polychlorinated Biphenyls
Dichlorvas	1,2-Dichloroethane	Trichlorobenzene
Atrazine	Simazine	Tributyltin compounds
Triphenyltin	Trifluralin	Fenitrothion
Azinphos-methyl	Malathion	Endosurfan

Chemicals

All postgraduate workers and staff are responsible for arranging the safe disposal of samples and chemicals that they have ordered but no longer require. This must be in consultation with Supervisors. At the termination of work, when keys are returned, affirmation will be required that all outstanding disposals have been dealt with. Charges may be made to Supervisors who persistently leave unwanted materials.

The following guidelines must be adhered to regarding disposal of chemicals:

- Purchase only enough chemical to complete your experiment.
- When designing and COSHH assessing experiments, remember to give due consideration to the safe disposal of waste.
- Toxic waste for disposal should be clearly labelled with details and concentration of contents, date and laboratory and user's name.
- Waste mercury from broken thermometers is best collected, stored under water and saved for recycling. Traces of mercury remaining should be treated with zinc or sulphur dust, brushed up and put into a screw-capped jar before sending for disposal.
- Advice should be sought from the School COSHH Adviser over material that requires specialized licensed disposal.
- Small quantities of material contaminated with chemicals that require incineration, for example, tips contaminated with ethidium bromide or acrylamide, should be placed in a YELLOW bag marked Biohazard and sent for incineration (see below). Keep this waste to a minimum.
- Large volumes of acid or strong alkali should be neutralised before washing to waste with copious quantities of water.
- Silica Gel Waste and other chromatographic media must be placed in labelled plastic containers. When full, the waste containers must be sent to the stores (do not place in the laboratory waste bins). Stores will continue to hold a stock of suitable plastic containers available on request.
- Under no circumstances should any chemical waste be placed in the normal laboratory waste bins; consult with technical staff if in doubt.

Solvents

- Waste solvents must be poured into properly labelled waste solvent containers (please remove original labels if re-using bottles). DO NOT throw solvents down the drains.
- Halogenated hydrocarbon waste should be segregated from non-halogenated hydrocarbon waste.
- As there is a real possibility of explosion of waste acetone and chloroform in the presence of alkali, ACETONE should only be added to the blue labelled waste bottles; if for some reason it is contaminated, then it should be sent for disposal in a separate container clearly labelled 'Do not mix with other waste solvent'.
- In general, waste solvent that contains a high concentration of acid or base should not be indiscriminately added to general waste solvent containers but disposed of separately.
- Decompose reactive materials before placing in waste solvent bottles.

Glass

There is a dedicated broken glass disposal bin in each laboratory. All chemicals must be rinsed off and any glassware used for microbiological work must be autoclaved before disposal as this glass is ground and recycled for road surfacing. Never put broken glass in ordinary waste bins in case of accidental injury to staff collecting the waste. Bottles and containers supplied by Fisher are recycled; these may be returned to the Stores for collection (wash out first please).

Sharps

Blades, hypodermic needles, capillary spotters and other 'sharps' should be placed in a yellow 'sharps' disposal container available from the Stores. Containers of biologically contaminated sharps should be autoclaved before disposal. Containers should then be placed in the yellow wheelie bin for incineration.

Green Waste

Low risk waste should be placed in the bins provided.

Disposal of Ionising Radiation Waste

See Section 10

Disposal of Biological Waste Material

See Section 12

10. IONISING RADIATION REGULATIONS AND PROCEDURES

Introduction

All persons wishing to work with ionising radiations for the first time must contact the School Radiation Protection Officer who will arrange for registration with the University Radiation Protection Officer.

Since January 2000 the University has been subject to the Ionising Radiation Regulations (1999) made under the Health and Safety at Work Act (1974), which protect individuals from injury at their place of work. Anyone working with radioactive substances (or equipment that produces ionising radiations) is subject to these regulations. The Health and Safety Executive (HSE) administers and checks compliance with the regulations. A copy of the relevant guidance notes and procedures is available at the documents page of the Health and Safety office website.

Radiation protection is based on three general principles:

- practices exposing individuals to ionising radiation must be justified by the advantages produced;
- exposures must be kept as low as reasonably achievable;
- the sum of doses received shall not exceed certain limits.

The University is also subject to the “Radioactive Substances Act” 1961 and 1994, which controls holdings of radioactive materials and their disposal.

Organisation

The University appoints both as Radiation Protection Adviser (RPA) (currently an external consultant) and a University Radiation Protection Officer (URPO). The function of the RPA is to advise the University, whereas the URPO is responsible for most of the day-to-day running of the University Radiation Protection Service. Part of the responsibilities of the SRPO are to:

- keep an inventory of radioactive materials stored throughout the University site, and to make returns as required by the Enforcing Authorities
- organise and control the correct disposal of radioactive waste
- leak-test sealed sources held within the University every two years.
- order and distribute all new radioactive material required by authorised users
- assess the need for personal dose monitoring of individual workers, organise the procurement and distribution of relevant dosemeters, maintain dose records for non-classified workers and to forward those for classified workers to the National Radiological Protection Board
- investigate and account for abnormal dose returns and to keep a record of all incidents and accidents involving ionising radiations.

The School Radiation Protection Officer (SRPO) oversees all matters concerned with radiation protection within the School and liaises with both the University Radiation Protection Officer and with specific Radiation Protection Supervisors (RPS) within the School who are responsible for proper supervision in specific laboratories/areas. The SRPO is to:

- ensure that the Local Rules, schemes of work and Regulations are adhered to
- ensure that suitable and appropriate training is provided for all radiation workers
- keep the URPO informed of all changes in the nature of the work in the School, and to assist in the reformulation of Local Rules and schemes of work to accommodate these
- ensure proper keeping of records for radioactive materials brought into the School, their usage and disposals
- ensure that all disposals are in accordance with the waste disposal certificates held by the University
- make regular checks and inspections of storage sites for radioactive materials and to monitor radiation levels at these sites, to monitor contamination of working surfaces etc. at least two times each year and to keep records of these checks
- monitor the scatter and leakage from any X-ray analytical equipment at least twice a year and to keep records of these measurements
- report to the URPO any irregularity noted during the above checks, or arising at other times
- arrange with the URPO for the disposal of waste
- inform the URPO of new workers in the School so that medical tests can be arranged for them if necessary and so that they can be interviewed by the URPO, and to inform the URPO when any worker ceases to work with ionising radiations or leaves the University
- organise, where necessary, free access to areas of the School by the URPO for inspections
- attend meetings of the Radiation Hazards Committee.
- arrange and ensure prompt distribution and collection of dose meters within the School.
- bring to the attention of the URPO any other matters of which he should be aware.
- act as Radiation Protection Supervisor in those areas where no other RPS has been appointed.

Within each laboratory working with open sources of ionising radiation the appointed RPS is responsible for ensuring adequate radiation protection procedures and training of workers in the area. In particular, the RPS is responsible for:

- ensuring that all workers within a particular group observe the Local Rules, Schemes of Work and Regulations.
- ensuring that suitable and appropriate training is provided for all radiation workers under her/his supervision.
- reporting to the SRPO any changes in the nature of the work carried out, and any incidents involving ionising radiations.
- keeping records of the acquisition of radioactive substances, their use and disposal, and providing such records to the SRPO as required
- informing the SRPO of new workers and helping in their training, and informing the SRPO of the cessation of radiation work by existing workers
- monitoring regularly, where appropriate and as laid down in the Local Rules, for radioactive contamination and leakage from equipment generating ionising radiations, and keeping records of such monitoring
- keeping a record of the location of sealed and unsealed sources, checking this inventory regularly at a frequency laid down in the Local Rules, and making these records available to the SRPO
- bringing to the attention of the SRPO any matter of which s/he should be aware.

Risk assessments must be made and local Rules and Schemes of Work written for each sphere of work involving ionising radiations to ensure that it is carried out in compliance with the Regulations. Copies of these rules and working procedures must be displayed in each laboratory and should be brought to the attention of all employees who may be affected by them.

It is the duty of the Head of School through the SRPO and RPSs to ensure that the local rules are adhered to and that all persons working in their School are properly trained in the safe use of all sources of ionising radiation.

It is the duty of each person whose work involves ionising radiations to ensure that the local rules are adhered to. Any person under the age of 18 or pregnant must consult the SRPO before considering any work with ionising radiations.

General Rules for Laboratory Use of Unsealed Sources

- All persons handling or using radioactive materials must be radiation workers registered with the University Radiation Services.
- At all times when radioactive material is being handled, full personal protection, a well-fitting laboratory coat, gloves and, where appropriate, eye and mouth protection, must be worn.
- Workers using 3H and 14C are not normally monitored (although in the case of 3H it may be necessary to assess internal dose using urine samples) and for 35S and 125I finger monitors are issued to new workers. Film badges are issued to users of 125I. Those using 32P must wear finger-monitors when handling undiluted or slightly diluted stock-solutions.

- The areas designated for use of radioisotopes handling are clearly delineated on laboratory plans available in each laboratory. Most of these are impervious surfaces, with a lipped front, but in some laboratories these benches are permeable and require covering in a suitably absorbent material such as “Benchcote” (absorbent side up). Non-designated areas must not be used for any work involving radionuclides.
- Work must be performed over drip-trays wherever possible.
- The normal restriction on eating, smoking etc applies to laboratories where work with ionising radiations is carried out.
- Anyone who has been handling or working with radionuclides in any form must wash his or her hands thoroughly before leaving the laboratory, even for a brief period. No one shall leave the laboratory wearing gloves that have been worn for handling radionuclides.
- All radioactive materials must be stored in a clearly marked, lockable cupboard or refrigerator when not in use.
- All dilution of radionuclides from stock solutions must take place at a designated site, which in the case of 32P, 35S, 22Na or 125I may be a controlled area.
- Transportation of radioactive materials from one laboratory to another should be restricted to the minimum. Radioisotopes must not be transported between buildings.
- All areas where radionuclides are handled must be checked regularly for contamination, following the guidelines in the Laboratory Rules, and a record made.
- Any contamination found must be removed, a record added to contamination records and both the SRPO and the URPO informed.
- Any accident or spillage, which involves radioactive materials, must be contained, the area sealed off and the SRPO and URPO informed immediately. Guidelines for dealing with spills and decontamination are available in all laboratories.
- Careful and complete records must be kept of all radioactive materials used, stating amounts drawn from stock and amounts disposed of, together with the method of disposal (sink, solid, scintillant). These records are collected by the URPO. The location of all sources must be known at all times.
- Once scintillant waste or counted tubes are deposited in designated containers for disposal the amount of radioactivity in the waste should be added to the sheet adjacent to the waste drum.
- Accumulation of waste material must be avoided. Waste is collected by the University Radiation Protection Service/URPO for storage and/or disposal.

Disposal of Ionising Radiation Waste

- Aqueous waste will be disposed of via a designated disposal sink leading directly to a sewer. The disposal amount and rate will be controlled by the availability of radioisotope and the protocols of the experiments. Care must be taken to ensure that licence limits are not exceeded. If there is any likelihood of the limit being exceeded, the RPA must be consulted before any disposal action is taken, in order that a protocol may be devised to prevent contravention.
- Solid and non-aqueous waste will be collected at the storage facility on Streatham Campus. Each container of waste will be identified by a unique serial number, assigned by the Radiation Service, when it is taken into the waste store.
- Very Low Level Waste (swabs, pipette tips, gloves, washed-out sample containers etc) must be collected in non-biodegradable white or black plastic bags of suitable robustness, double-thickness, held in a suitable waste-bag support (for radiophosphorus this should be a purpose-made box of acrylic of minimum thickness 7 mm, with a lid) labelled to indicate that radioactive materials only must be disposed of there, and where

separate waste steams are maintained, to identify which bag is for which waste type. The bags themselves should not be marked as radioactive. When a bag is full, the Radiation Service must be informed, and arrangements made to collect the bag with minimum delay. When it is collected, the bag will be marked with a radiation symbol, which can be removed when it is finally disposed of.

- Each container of scintillation and other counted radionuclide samples must bear a radioactive warning sign and a legend identifying it as radioactive waste. It must have associated with it a schedule listing each disposal, with the activity disposed of, and a running total of activity in the container. When the container is full and passed to the Radiation Service for disposal, this schedule (or an exact copy thereof) must accompany the container at all times. On the container being taken into the waste store, the schedule will be assigned the same identifying code as the container to which it relates.
- Non-aqueous waste disposal routes as follows:
    - Dustbin waste – pipette tips, swabs, gloves etc – are collected in bags, recorded, checked for radioactive emission and placed in dustbins at a controlled rate.
    - Rapidly-decaying isotope waste (Phosphorus-32 and 33, Cr-51, I-125) will be separated from other isotope waste and stored for decay to minimise environmental impact. When it has decayed for a suitable period (such that the activity is demonstrably below the statutory limits) it will be disposed of to dustbin.
    - Scintillation waste will be disposed of regularly to our licensed disposer, Shanks Waste Solutions at Fawley.

Permitted dose limits

These are laid down in the relevant guidance notes at the documents page of the Health and Safety office website, as follows:

- The limit on effective dose for any employee over 18 years of age shall be 20 mSv in a calendar year (but note there are further levels for equivalent doses for the lens of the eye and for the skin, and effective dose hands, forearms, feet and ankles)
- The limit on effective dose for any trainee under 18 years of age shall be 6 mSv in a calendar year (again with further (and different levels for the categories as noted above)
- In addition to both the above, the limit on equivalent dose for the abdomen of a woman of reproductive capacity shall be 13 mSv in any consecutive period of three months.
- The limit on effective dose for any person not an employee or trainee shall be 1 mSv in any calendar year.

The action levels on dose returns are specified as below for monitored workers:

- Zero dose return - no action.
- 0 - 0.5 mSv - await next dose return. If a second measurable dose is recorded, alert SRPO.
- 0.5 - 1 mSv - alert SRPO, request investigation and review of handling techniques.
- Above 1 mSv - initiate full investigation without delay.

Permitted holdings and disposal limits for unsealed sources

These are listed within the relevant guidance notes at the documents page of the Health and Safety office website.

11. NON-IONISING RADIATION - LASER SAFETY

Laser Safety Organisation

The School Laser Safety Officer (SLSO) oversees all matters concerned with laser safety within the School and liaises with both the University Radiation Protection Officer and with specific Laser Safety Supervisors (LSS) within the School who are responsible for safe Schemes of Work and supervision in their specific areas. Terms of reference for and responsibilities of the School Laser Safety Officer, and Laser Safety Supervisors are contained within University of Exeter Local Rules for the use of Lasers and the Association of University Radiation Protection Officers "Guidance on the Safe Use of Lasers in Education and Research".

Risk Assessments must be performed, and Local Rules and Schemes of Work must be written for each sphere of work involving lasers of classes 3B and 4. These rules should be brought to the attention of all employees and students who may be affected by them and should be displayed at each work area. These rules may in the first instance be drawn up by the user of the laser, but they must be approved and ratified by the SLSO and/or the LSS. It is the duty of the Head of School through his SLSO and LSS to ensure that the Local Rules are adhered to, and that all persons working with lasers in his School are properly trained in their use. It is the duty of each person whose work involves a laser to ensure that the Local Rules and safety procedures are adhered to.

Classification of Lasers

All working laser systems purchased from a manufacturer must carry a label stating the class of that system. This should not be removed or altered in any way unless the system is itself modified in such a way as to alter its class. Should this be done, the Laser Safety Service must be consulted over the reclassification of the system. In line with variously agreed national and international standards all lasers are assigned an appropriate classification. The criteria for the assigning of a class to a laser system are complex. A broad indication of the meaning of the class and the implications for the system it describes are contained within the Local Rules for the use of Lasers and the Association of University Radiation Protection Officers "Guidance on the Safe Use of Lasers in Education and Research", and are summarised briefly below:

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- Class 1. Lasers that are safe under reasonably foreseeable conditions of operation.
- Class 1M. Lasers which are safe under reasonably foreseeable conditions of operation, but may be hazardous if the user employs optics within the beam
- Class 2. Lasers that emit visible radiation in the wavelength range from 400 nm to 700 nm where adequate eye protection under reasonably foreseeable conditions is normally afforded by aversion responses, including blinking.
- Class 2M. Lasers as per Class 2 but viewing of the output may be more hazardous if the user employs optics within the beam.

- Class 3R. Lasers where direct intrabeam viewing is potentially hazardous but the risk is lower than for Class 3B lasers.
- Class 3B. Lasers which are normally hazardous when direct intrabeam exposure occurs
- Class 4. Lasers that are also capable of producing hazardous diffuse reflections. They may cause skin injuries and could also constitute a fire hazard. Their use requires extreme caution.

For rule-of-thumb purposes, for continuous-wave lasers, Class 2 lasers are powered below 1 mW, Class 3R lasers between 1 and 5 mW, Class 3B lasers between 5 and 500 mW, Class 4 lasers anything above this power.

Purchase and Installation of Lasers

A central register of lasers is maintained by the University Radiation Protection Service. In order that this may be kept up-to-date, the University Radiation Protection Officer (URPO) must be advised **IN WRITING** of the arrival of any new laser, and its situation, by the School Laser Safety Officer. The URPO will wish to inspect the installation of any newly-acquired or re-sited laser of class 3B or 4. Any laser manufactured on the University premises must be reported to the URPO before it is made operational, and again when it becomes operational, so that it may be entered on the inventory, and its output and labelling checked.

Before any new laser experiment is performed, or new laser of class 3B or 4 taken into use, a full Hazard and Risk Assessment must be made, and the successful completion of this must also be confirmed to the URPO.

All lasers must bear warning labels, and it is the responsibility of the purchaser or maker to ensure that these are affixed. The University Radiation Protection Service can advise and provide labels where necessary. The required labels are:

- A "Triangle and Starburst" label.
- A label stating the class of laser.
- A label listing any hazards associated with the radiation.
- A label detailing the output of the laser (wavelength, visible/invisible, etc)
- A label indicating (preferably with an arrow design) the laser aperture.

The door of any laboratory where a laser of class greater than 1 is installed for use must bear a "Triangle and Starburst" warning label. If a laser of class 3B or 4 is installed for use, this warning label must in addition bear the legend, "**DANGER, laser beam**", and the door must bear a notice stating the class of laser present.

No warning label is required on the door of any room where a laser of class 1 or 2 is in use temporarily for setting-up, alignment or demonstration purposes. However, all normal precautions must be taken to avoid accidental exposure of any eye to the beam.

General Rules for the Operation of Lasers

- Before using any laser, ascertain its class and acquaint yourself with the special rules and restrictions which apply to that class of laser. Ensure that you have studied any Risk Assessment and experimental protocols relating to the laser (these should exist for any laser of class 3B or 4).
- Under no circumstances may the output of a laser be viewed along its beam-path either directly, by specular reflection or with the aid of an optical instrument. In other words, **NEVER LET A LASER BEAM ENTER YOUR EYE**.
- Always ensure that the laser beam cannot extend beyond its useful limit. A suitable beam-stop must be used to prevent the beam from leaving the experimental area.
- Do not use a laser of a higher class than is necessary for the purposes of the experiment.
- Do not tamper with an experimental setup in such a way as to negate the safety precautions and beam-limiting devices that have been incorporated.
- Where an instrument incorporates a laser whose beam-path is protected by shielding and interlocks, **DO NOT UNDER ANY CIRCUMSTANCES** interfere with or attempt to override those precautions.
- At the conclusion of an experiment, ensure that the laser is switched off or returned to a safe condition. **NEVER LEAVE AN ACTIVE LASER UNATTENDED.**
- Never forget that a laser is a potentially dangerous power-source, and not a toy. Anyone found misusing a laser in any way will be subject to disciplinary action, and may be prevented from further use of lasers.
- Always remember that you are responsible for the safety of others as well as yourself.
- Always design and operate experiments in such a way as to eliminate all foreseeable dangers.
- Guard against other, non-optical hazards associated with lasers, such as high voltage electricity, charged capacitor-banks, toxic chemicals for dye-lasers etc.

Lasers of classes 3B and 4

No undergraduate may have access to, or use, these classes of laser. A hazard and risk assessment MUST exist for every laser of these classes. The design of the laboratory in which the laser is used should incorporate:

- complete absence of all specularly-reflecting surfaces (e.g. mirrors, glass-doored cupboards, bottles, polished apparatus, beam-path element holders, etc.) that are not an integral part of the beampath or experimental equipment.
- a high light-level, enhanced by light-coloured walls. This has the dual effect of making the laboratory safer to move around in and of ensuring that the pupils of the eyes of all workers are as far closed as possible to restrict the aperture of the eyes.
- a light system outside the laboratory door to warn unauthorised persons against entering the experiment zone. These should be interlocked with the laser switching circuitry, and fail-safe in design. A system of interlocked and fail-safe switches on the access doors either to switch off the laser or release shutters to occlude the accessible beam in the event of unauthorised access is desirable, but may not be appropriate in all cases.

All users of these classes of laser must be registered with the University Radiation Service as laser users, and must undergo training in the use of the laser to which they are registered, including the correct operation of safety procedures and interlocks. No ophthalmic testing is required. All new workers must sign a declaration that they have received training and have read and agree to abide by the relevant instructions and rules.

As far as is consistent with ease of use and safe handling, the beam-path of these classes of laser should be enclosed when the laser is in operation. Where this is not possible, guard-rails or screens should be provided to prevent accidental access to the beam. These lasers may never be operated hand-held; they may only be operated when secured in the required position.

The use of laser goggles is dependent upon the particular circumstance. While they can act as a safeguard, especially for onlookers, they can create a false sense of security, and by rendering a visible beam invisible can in fact create a hazard. However, when setting-up or aligning an open beam and in all cases when working with beams of wavelengths outside the visible spectrum, the use of the appropriate laser goggles is recommended.

Lasers of these classes must incorporate a key-switch to which only authorised users are issued the key. Keys must not be left permanently in the switch when the laser is not operating.

Laser Pointers

Laser pointers in Classes 1 and 2 will not be subject to registration when used for teaching purposes. Laser pointers in Class 3R must be registered with the University Radiation Protection Service. Registration will be limited to members of staff and Ph.D. and equivalent students whose application is supported by the School. Pointers in these classes have the potential to cause serious irreversible damage to the eye and there are strict rules governing their use (refer to the guidance documentation as before for non-ionising radiation, available from the documentation page of the Health, Safety and Environment Office website.

Laser pointers in Class 3B and above will not be registered or permitted for use by the University.

Although most laser pointers are marked with a class number, there have been instances of pointers exceeding the stated class. Also, American classification differs somewhat from the European system. The University Safety Office has equipment to measure the power output of lasers, and will be pleased to help where doubt exists.

Radio-Frequency Heaters

Apart from the risk of electric shock and burns arising from direct contact with the equipment, radio-frequency heating coils are hazardous in that they can induce dangerous voltages and heating currents in neighbouring conductors. Suitable screens should be provided to avoid dangerous voltages being induced in neighbouring metallic equipment which should also be effectively earthed. All metal ornaments such as rings, watches etc should be removed from the hands and wrists when working with radio-frequency heaters.

Ultra-Violet Radiation

Ultra-violet radiation shorter than approximately 340nm is extremely damaging to the eyes. Conjunctivitis generally results 4-8 days after exposure. Ultra-violet sources should always be properly shielded and eye protection worn by those working in the immediate vicinity of exposed

sources. The principal sources of UV radiation are ultra-violet lamps, such as those used for sterilisation and electric arc welding.

12. BIOLOGICAL HAZARDS

General

It is imperative that all personnel who deal with biological experimental procedures should be conscious of the possible hazards that may arise. If in doubt you must consult your veterinary or medical/clinical partners.

A bacteriological risk arises from any procedure which releases micro-organisms into the environment or which otherwise allows them access to the human body. Infection may be initiated by inhalation, ingestion, through the broken or unbroken skin, or the conjunctiva.

Many laboratory activities with fluids produce aerosols. When a fluid surface is broken large number of small droplets are produced. This may happen when a bubble bursts, when two solid surfaces separated by a film of liquid are parted, when one liquid is poured into another and when drops of liquid are allowed to fall on to a solid surface. The larger droplets fall to the ground, but the smaller ones evaporate rapidly and if the fluid contains bacteria these remain suspended as infected air-borne particles or droplet nuclei. The small particles, between 1 and 5 μm remain suspended for long periods and if inhale penetrate directly into the lung. Larger particles are removed in the upper air passages.

Aerosol production is dangerous not only to the operator but to all other persons in the vicinity. Even screw-capped bottles may present some hazards. A thin film of liquid may be present between the rim of the bottle and the rubber liner. When this film is broken by removing the cap aerosols are formed.

Gross contamination of surfaces and of clothing by spilled or broken cultures may result in infection by the hand-to-mouth route, to infection of existing skin lesions and to eye infections. The possibility of systematic infection by the conjunctival route must also be considered.

Direct ingestion is usually associated with mouth pipetting, failure to wash the hands, direct consumption of foods in the laboratory and smoking at the work bench.

Faulty techniques with hypodermic needles, and accidents with broken glass may lead to direct inoculation into the blood stream. Contamination of the skin with blood may lead to infection directly or through minor abrasions, e.g. Hepatitis B.

The ideal specimen container for pathological material must be easy and convenient to use by the patient and doctor without the outside being contaminated. It must be leak proof and virtually unbreakable: it should not create undue aerosol or spillage hazards when opened in the laboratory, and it should be easily sterilised, washed, or disposed of.

Screw-capped bottles may present some hazards (see Section 8.2.5). This risk is very much greater in containers that have ‘snap-on’ or ‘pop-up’ closures or bungs, or have ‘screw-in’ plugs. A larger film of liquid is easily trapped between the top of the container and the closure particularly after shaking in transit. It is very difficult to open these containers gently, as is possible with a screw-capped bottle; and the abrupt movement releases large amounts of aerosol and often a visible spray. These containers and many others in which any part of the closure is inside the tube may be dangerous and should not be used. Unfortunately they have become very popular for the collection of blood specimens for haematological and biochemical purposes. Hitherto these have been regarded as harmless, but a proportion of these samples is now known to contain Australia-Antigen.

Some screw-caps, particularly those made of plastic, seem to become loose spontaneously.

Sera sent from one laboratory to another should be dispatched in the smaller glass screw-capped (Bijou) bottles.

Good Working Practices

- All procedures should be performed so as to minimise the production of aerosols.
- The laboratory door should be closed when work is in progress.
- Laboratory coats must be worn in the laboratory and removed when leaving the laboratory.

- Personal protective equipment, including protective clothing, must be:
    - stored in a well-defined place;
    - checked and cleaned at suitable intervals;
    - when discovered to be defective, repaired or replaced before further use.
- Personal protective equipment which may be contaminated by biological agents must be:
    - removed on leaving the working area;
    - kept apart from uncontaminated clothing;
    - decontaminated and cleaned or, if necessary, destroyed.
- Eating, chewing, drinking, taking medication, smoking, storing food and applying cosmetics is prohibited in laboratories.
- Persons working in biological laboratories should adhere to a strict code of personal hygiene
- Hands must be decontaminated immediately when contamination is suspected, after handling infective materials and before leaving the laboratory. When gloves are worn, these should be washed or preferably changed before handling items likely to be touched by others not wearing gloves, for example, telephones, paperwork, computer keyboards and, where practicable, equipment controls should be protected by a removable flexible cover that can be disinfected.
- Mouth pipetting is forbidden.
- Bench tops and work surfaces should be regularly decontaminated according to the pattern of work and should be cleaned after use.
- Used glassware and other materials awaiting disinfection should be stored in a safe manner. Pipettes, for example, if placed in disinfectant, should be totally immersed.
- Material for autoclaving should be transported to the autoclave in robust containers without spillage.
- There must be safe storage of micro-organisms.
- All waste material, if not to be incinerated, should be disposed of safely by other appropriate means.
- Accidents and incidents must be immediately reported to and recorded by the person responsible for the work or other delegated person.
- Effective disinfectants should be available for immediate use in the event of spillage.
- The laboratory should be easy to clean. Bench surfaces should be impervious to water and resistant to acids, alkalis, solvents and disinfectants..
- Minimum paper only should be in laboratories ie essential paperwork and laboratory books only.
- All infectious and toxic materials should be correctly labelled and storage areas should show appropriate warning notices.
- Laboratories handing biological materials which could cause illness should have a system whereby illness is reported without delay.
- Great care should be exercised in using hypodermic syringes. Apart from the risk of accidental self inoculations, spraying may occur if a needle becomes loosened from the syringe during an injection.
- Laboratory personnel must receive suitable and sufficient information, instruction and training in the procedures to be conducted in the laboratory.
- Training received must be recorded on a laboratory proforma and signed by the trainee. This should also include details of relevant documents read.
- Every researcher must have a nominated academic supervisor responsible for ensuring compliance with these rules.
- Individuals working with micro-organisms must ensure that other persons eg cleaners, maintenance personnel, visitors etc are not exposed to biological hazards.

- Portering staff must only deal with general waste and do not handle autoclaved, biohazardous or other similar waste. This must be dealt with (including transportation to the wheelie bins) by lab workers.
- Project students and other undergraduates working with micro-organisms require close supervision, the safety and security of these individuals is paramount

Handwashing Facilities

Hand basins with hot and cold running water must be provided in all laboratory rooms. There should be at least one basin in each room. In rooms where a large number of people work, e.g. more than 10, it is desirable that two basins be provided. The basins should be near to the doors. Ideally, taps should be operable without needing to use hands.

Automatic liquid soap dispensers should be avoided in favour of tablets of toilet soap regardless of the alleged economy of the former. Many of these dispensers must be operated by dirty or contaminated hands before they yield soap. It may not be obvious when they are empty.

Paper towels in dispensers are much more satisfactory than Turkish or huckaback towelling. These cloth towels are usually changed on a rigid time basis and may remain wet and dirty for long periods. Roller towels are acceptable only if they are of the continuous flow type and are properly maintained and promptly replaced.

As a general rule hands should be washed, preferably with a bactericidal soap, after completing any work and always before leaving the laboratory.

Health

Individuals with medical conditions which predispose them to infection (eg eczema, compromised immune systems, diabetes etc) are at a special risk. Everyone must notify their supervisor of any illness or other medical condition that may compromise the immune system and may make them more susceptible to hazards, which may arise through working with micro-organisms.

Health surveillance is required under COSHH where:

- there is an identifiable disease which may be related to workplace exposure;
- there is a reasonable likelihood that exposure may happen;
- there are valid techniques for detecting indications of the disease or its effects.

Autoclaves

Most biological agents (including bacterial and fungal spores) can be rendered non-viable by exposure to steam under pressure. The hazard from adequately treated material should be very low. Sterilisation depends on steam penetrating to all parts of the load. Lids must be removed and plastic bags undone. The efficiency of sterilisation should be verified by one of the following methods:

- A thermocouple placed in the load will indicate how long the load takes to heat up to the chosen sterilisation temperature and how long the autoclave should be maintained at this temperature. A safety margin should be included to ensure sterilisation.
- Spore strips may be placed in the load but, as they have to be incubated, do not give an instant indication.
- Some indicator devices (eg “Thermolog” strips) may give a reasonably reliable indication of sterilisation and (subject to risk assessment) be suitable for day to day use where thermocouple tests are impracticable.
- Ordinary autoclave tape, however, does not give a reliable indication of sterilisation.

Autoclave procedures

- Waste destruction conditions need to be verified and specified to fall in line with appropriate licences for the area. The norm is 1 hour at 121ºC (15psi).
- Procedures for final disposal need to be specified in the procedure. Portering/cleaning staff must not be required to handle such material.
- Autoclaves must be operated by trained, competent staff and manufacturer’s instructions must be followed.
- Heat resistant gloves and a face visor should be worn.
- Loads containing bottled fluids must be cooled to below 80ºC before removal from the autoclave (otherwise they may explode).
- Items which may explode, release toxic fumes etc or corrode surfaces must not be autoclaved.
- Autoclaves must be periodically inspected (as pressure vessels), tested, maintained and records must be kept *(Pressure Systems Safety Regulations 2000).*

Disinfection

Disinfection is a less reliable means of sterilising materials than autoclaving. Disinfectants must be chosen carefully as there is no universal disinfectant, all have disadvantages. Disinfectants may deteriorate on standing or be inactivated by detergents, organic matter etc. and most are toxic or irritant. Some common types are listed below:

Hypochlorite solutions:

- Commonly recommended concentrations – 1,000 ppm for surface decontamination, 2,500 ppm for discard containers, 10,000 ppm for spillages.
- These are active against bacteria (including spores) and viruses but have limited activity against fungi and tubercule bacilli.
- Are compatible with anionic/non-ionic detergents but corrode many metals and damage rubber and are inactivated by organic materials and so need frequent changing.

Chlorine releasing granules:

- Usually contain sodium dichloroisocyanurate (NaDCC) and may also contain absorbent powders. They have a relatively long shelf life and are useful for spillages.

Clear soluble phenolics:

- Active against vegetative bacteria (including tubercule bacilli) but not active against spores and have a limited effect on fungi. They are not active against many viruses (particularly if not lipid containing).
- Compatible with anionic/non-ionic detergents and metals and inactivated by rubber and some plastics
- Hycolin has a new formulation and is not reliable.

Glutaraldehyde:

- Has similar range of activity to hypochlorites but should not corrode metal.
- Does not readily penetrate organic matter and is relatively unstable once inactivated.
- Is a potent allergic sensitizer.

Alcohols:

- Are normally used as 60-80% vv solutions in water.
- Are active against protozoa and many viruses and vegetative bacteria (but not tubercule bacilli).
- Can be used as a disinfectant skin rub (often with addition of 5% wv chlorhexidine)
- Do not readily penetrate organic matter.
- Are flammable.

Virkon:

- Claimed to be active against many types of organism.
- Relatively non-toxic and non-corrosive.

Disposal of Biological Waste Material

It is important that biological waste is disposed of safely. Appropriate sterilisation procedures must be used prior to disposal of any material contaminated with micro-organisms.
Some guidelines:

- *Unlicensed Waste for autoclaving.* Material should be placed in clear plastic autoclave bags for standard autoclaving at 121°C for 60 minutes before disposal.
- *Licensed Waste eg plant pathogens.* Material should be placed in RED plastic bags for autoclaving at 121°C for the time specified on the licence (usually 1-2 hours).
  Material from the microbiology suite should then be placed in a yellow bag and taken to the yellow waste for incineration wheelie bin in the stores yard. Other autoclaved material such as large quantities of soils should be placed in a black bag and placed in the general waste wheelie bin**.**
- Unlicensed waste for incineration. Material that is unsuitable for autoclaving (including small quantities of some chemical waste that requires incineration) would be placed in special YELLOW Biohazard labelled bags. These bags should be filled no more than ¾ full and securely sealed. The bag must be labelled with the lab., building and date of filling. This bag should then be placed in the yellow wheelie bin in the stores yard. The key is with the storekeeper. The material is then sent for incineration. Keep this waste to a minimum.

Further guidance on standard operation procedures for waste disposal is given in Appendix 5 of *The Management, Design and Operations of Microbiological Containment Laboratories.*

Action in the event of spillage

There must be contingency plans for dealing with foreseeable emergencies. These could include spillage control, room evacuation, fumigation and decontamination and, if there is a risk of infection - first-aid and medical treatment (prophylazis) and health surveillance and counselling of exposed people.

Items required for dealing with spillages etc must be readily available and all workers must know the procedures. Guidance is given in Appendix 3 of *The Management, Design and Operation of Microbiological Containment Laboratories.*

In the event of an accident/incident/emergency, immediate steps must be taken to mitigate the consequences. Only people essential for carrying out repairs and other essential work may be permitted in the affected area and they must be provided with appropriate personal protective equipment and any necessary equipment or plant. Employees (or their representatives) must be informed as soon as practicable after an incident or accident that has (or may have) resulted in the release of a biological agent that could cause severe human disease. Employees must report such incidents or accidents forthwith.

If there is a risk of airborne infection the laboratory must be evacuated as quickly as possible. It may be necessary to fumigate the room before reoccupation.

- Spillages should be contained and covered with disinfectant granules or absorbent paper/cloth soaked in disinfectant.
- The disinfectant should be allowed to act for at least 15 minutes.
- The debris should be swept gently into a dustpan using a piece of board or stiff card.
- Any residual pieces of glass etc should be picked up with forceps or swabs.
- Debris should be put in a suitable container for disposal by a safe route; and
- Further disinfectant should be applied to contaminated surfaces.
- Rooms must not be re-occupied until it is safe to do so.

People attending casualties should avoid becoming contaminated themselves.

- Contaminated clothing must be removed as quickly as possible.
- Remove contamination of skin/eyes/mouth by thorough washing with clean water.
- Eyes should not be rubbed nor skin scrubbed.
- Small puncture wounds should be encouraged to bleed; minor cuts and similar lesions should be washed with soap and water or a suitable detergent before being thoroughly washed and dressed; and
- Medical advice must be sought if there is a risk of infection.

Surveillance of exposed persons and possibly their close contacts may be required. Counselling may be necessary. If there is a health risk to the community there must also be contingency plans, made in consultation with local community physicians to limit spread:

- Identification and tracing of contacts;
- Testing, vaccination or prophylaxis of contacts;
- Isolation and treatment of infected people;
- Control of animal vectors

Containment measures

The term “containment” describes the way in which biological agents are managed in the laboratory environment so as to prevent or control the exposure of laboratory workers, other persons and the outside environment to the agent(s) in question. This is achieved by a combination of measures.

Primary containment, ie, the protection of the worker and the immediate environment can be achieved through a combination of good microbiological practices/ techniques and the use of appropriate safety equipment, eg, microbiological safety cabinets. Further protection may be achieved through the use of appropriate immunisations, although this should be seen only as a useful supplement to reinforce procedural controls and the use of safety equipment, not the sole protective measure.

Secondary containment, ie, the protection of the people and the environment outside the laboratory can be achieved by a combination of laboratory design, engineering controls and operating procedures.

Containment measures must be reviewed at suitable, regular intervals and immediately if there is reason to suspect that the measures are no longer adequate or, if in the light of new scientific or technical knowledge, the assessment is inadequate. Laboratory containment measures must reflect the nature and severity of the biological hazard; an outline guide is provided in the table below.

	Laboratory Containment Level		
Containment Measures	**1**	**2**	**3**
Laboratory suite: isolation	Not required	Not required	Required
Laboratory sealable for fumigation	Not required	Normally required, depending on the workplace risk assessment	Required
Equipment			
Surfaces impervious to water and resistant to acids, alkalis, solvents, disinfectants, decontamination agents and easy to clean	Required for bench	Required for bench and floor	Required for bench, floor, ceiling and walls
Entry to lab via airlock	Not required	Not required	Required
An inward airflow into the laboratory (negative pressure) must be maintained by extracting room air to atmosphere	Not required	Required where indicated in risk assessment	Required
Extract and input air from the laboratory must be HEPA filtered (H14 standard tested to 99.997% efficiency)	Not required	Not required	Single HEPA filters required for extract air, single HEPA filters for input air
Use of a microbiological safety cabinet/enclosure	Not required	Required where there is a risk of aerosol generation	Required, Class I/III cabinet or isolator
Autoclave	Required on site	Required in the building	Autoclave required in the laboratory
System of Work			
Access restricted to authorised personnel	Required	Required	Required (key pad lock required)

Specific measures to control aerosol dissemination	Not required	Required so as to minimise	Required so as to prevent escape from primary containment
Shower	Not required (unless required for chemical safety)	Not required (unless required for chemical safety or if large volumes/high concentrations to be used)	Required – emergency use
Protective clothing	Suitable protective clothing required	Suitable protective clothing required	Suitable protective clothing required; footwear required where and to the extent the risk assessment shows it is required
Use of disposable gloves	Required where indicated in risk assessment	Required where indicated in risk assessment	Required
Efficient control of disease vectors	Required where and to the extent the risk assessment shows it is required	Required	Required
Specified disinfection procedures in place	Required	Required	Required
Biohazard sign displayed on laboratory door, fridges, freezers and transport containers	Required	Required	Required
Waste			
Inactivation of biohazards in effluent from hand-washing sinks and showers and similar effluents	Not required	Not required	Required where and to the extent the risk assessment shows it is required
Inactivation of biohazards in contaminated material and waste	Required by validated means, where and to the extent the risk assessment shows it is required	Required by validated means	Required by validated means
Other Measures			
Laboratory to contain its own equipment	Not required	Not required	Required, so far as is reasonably practicable
An observation window or alternative is to be present so that occupants can be seen	Required where and to the extent the risk assessment shows it is required	Required where and to the extent the risk assessment shows it is required	Required

Safe storage of biohazardous material	Required where and to the extent the risk assessment shows it is required	Required	Secure storage required
Telephone or intercommunication system between the laboratory and the clean outside area	Required	Required	Required
Written records of staff training	Required	Required	Required
Space for laboratory workers	There must be adequate space (at least 11m^3) in the laboratory for each worker	There must be adequate space (at least 11m^3) in the laboratory for each worker	There must be adequate space (at least 24m^3) in the laboratory for each worker

Microbiological safety cabinets

Where used, be aware that there is a legal requirement to check these cabinets for operation and containment. High Efficiency Particulate Air (HEPA) filters used in microbiological safety cabinets are to be checked by a professional engineer twice per year, and the potassium iodide test is performed annually. Class 1 Safety Cabinets minimize escape of aerosols by drawing air in through the open front. The air passes through a high efficiency particulate air (HEPA) filter and is then discharged (usually to the outside). These cabinets protect the worker but not the work. There is a device (anti-blow back valve) to prevent back flow of air if the fan fails. Class 2 Safety Cabinets are designed such that air is drawn through the open front of the cabinet, but instead of going upwards, it is drawn downwards through grills in the base of the cabinet. The air passes up the back of the cabinet and is HEPA filtered. A proportion is vented (again normally to the outside) while the rest is re-circulated downwards through the working area providing a curtain of filtered air. These cabinets protect both the worker and the work from contamination and are particularly useful for handling cell cultures. Class 3 and Class 1/3 Safety Cabinets provide a totally enclosed working area and the operator wears long rubber gloves which are attached to the front panel. Incoming air is HEPA filtered once and outgoing air twice. Both work and worker are protected but this type of cabinet is normally only necessary in Containment Level 3/4 laboratories. Laminar Flow Cabinets may be used for preparing media and pouring plates only. They can be horizontal or vertical flow type. With these cabinets, the direction of flow is outwards towards the worker providing a sterile working environment for procedures such as plate pouring only. Because of the outward flow of air there is no protection for the worker and therefore these cabinets must not be used for handling any pathological materials or cultures of any micro-organisms.

Animals

Any animals should be kept in suitable housing to which only authorised persons have access. Any laboratory animal, whether stock or experimental, may excrete an infectious agent in its faeces, urine, saliva or expired air. Infection of handlers is also possible by direct transmission during handling; from bites and scratches, from contact with or inhalation of dust from cages and bedding; and from contact with blood or with tissues removed at autopsy.

Infected animals may not be obviously ill; infections may be subclinical. Therefore all laboratory animals at all stages of their progress through an animal house must be treated as potentially infectious. Anyone bitten by an animal should be treated by a medical officer.

Reference material

- Health and Safety at Work Act (HASWA) 1974 and the European Communities Act 1972 and regulations within, including Control of Substances Hazardous to Health (COSHH) 2002 Regulations (as amended)
- The Management, Design and Operation of Microbiological Containment Laboratories. Advisory Committee on Dangerous Pathogens. HSE Books 2001
- Biological agents: managing the risks in laboratories and healthcare premises. Advisory Committee on Dangerous Pathogens. HSE Books 2005. http://www.hse.gov.uk/biosafety/biologagents.pdf
- Categorisation of biological agents according to hazard and categories of containment. Advisory Committee on Dangerous Pathogens. 1995. Fourth Edition
- The Approved List of Biological Agents. Advisory Committee on Dangerous Pathogens. HSE 2004. http://www.hse.gov.uk/pubns/misc208.pdf
- Work with agents listed by DEFRA as specified animal pathogens may require a DEFRA licence(s). Advice should be sought from the Biological Safety Advisor. The list of specified animal pathogens can be found at: http://www.defra.gov.uk/animalh/diseases/pathogens/index.htm
- Home Office Anti-Terrorism, Crime and Security Act (ATCSA) 2001 (http://www.homeoffice.gov.uk/security/terrorism-and-the-law/anti-terrorism-crime-security-ac/) and pathogens listed under Schedule 5 (http://www.opsi.gov.uk/acts/acts2001/ukpga_20010024_en_18#sch5)
- Safe Working and the Prevention of Infection in Clinical Laboratories (HSAC)
- Laboratory-Acquired Infections (Collins)
- Biological Safety: Principles and Practices (ASM).
- Air Transport - ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air. The Air Navigation Order 2005 SI 1970 provides the legal basis for the Air Navigation (Dangerous Goods) Regulations 2002 (SI 2786) (As amended)
- Road and Rail Transport – ADR European Agreement concerning the International Carriage of Dangerous Goods by Road
  RID Regulations concerning the International Carriage of Dangerous Goods by Rail
  The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004 (SI 568) as amended
- Maritime Transport - IMDG International Maritime Dangerous Goods (Code)
  The Merchant Shipping (Dangerous Goods and Marine Pollutant) Regulations 1997 (SI 2367)

13. TRANSPORT

Use of the School's Vehicles

The School of Physics has a vehicle which may be driven by authorised persons on the School's business.

- If you need to use the vehicle, contact the Stores
- Drivers are advised that the University Motor Insurers, Commercial Union, involve excesses in cases where claims involve drivers under the age of 24, and over 25 years of

age, where a full driving licence has not been held for 12 months. Drivers qualified to avoid the excesses should drive wherever possible.

- Private vehicles should not be used for School business when the School's vehicle is available (see below).
- In the event of an accident involving damage to persons or property other than the School's vehicle or its occupants: details must be reported to the persons involved (or the owner of the property) or to the police and also to the School Manager, Head of School and the Academic Registrar and Secretary of the University. If only the School vehicle is damaged, a report need only be made to the Laboratory Superintendent.
- The University Insurance Office holds the certificates of insurance of the vehicles.
- Only authorised persons may travel in School vehicles.
- Any unauthorised use or the misuse of vehicles may lead to withdrawal of the privilege of using them
- Users must ensure that the vehicle is in a safe condition (check the oil and water and condition of tyres etc) before a journey.
- First aid kits are kept in each vehicle.

Use of Private Vehicles on the School's Business

It is recommended that personnel use the hired vehicles or School's vehicle whenever possible. If the use of a private vehicle is unavoidable then the following points must be considered:

- The vehicle must be taxed, road-worthy and suitable for the intended purpose.
- The insurance cover must be adequate, ie, it must specify for business use.
- The Supervisor/Head of School considers such a use is necessary.
- The driver holds a full UK driver's licence.

A pro forma (available from School Finance office) for Staff Use of Private Vehicles on University Business must be completed and signed, and countersigned by the School Manager.

Minibus Passenger Transport Vehicles

Although fatal accidents involving minibuses are rare, recent examples have underlined dangers specific to this form of transport. It will not be possible to completely eliminate the dangers associated with driving minibuses, but practicable means exist to reduce the likelihood of an accident occurring and mitigate the extent of personal injury. Details of safety procedures and precautions are available via the documents page of the Health and Safety office website.

14. MANUAL HANDLING OPERATIONS

Accidents causes by manual handling account for 37% of all reported accidents; most commonly these are sprains or strains particularly of the back. Sprains and strains arise from the incorrect application and/or prolonged use of bodily force. Poor posture and excessive movement are important contributory factors. Many manual handling injuries are cumulative rather than attributed to one single injury. A full recovery is not always made; the result can be physical impairment or even permanent disability.

The Manual Handling Operations Regulations 1992 require the University to assess manual handling operations undertaken by its employees. Heavy, difficult and repetitive loads require a written assessment to be completed. Appropriate steps must be taken to reduce the risk of injury to the lowest level practicable. Contact M Grapes if you consider an assessment is required.

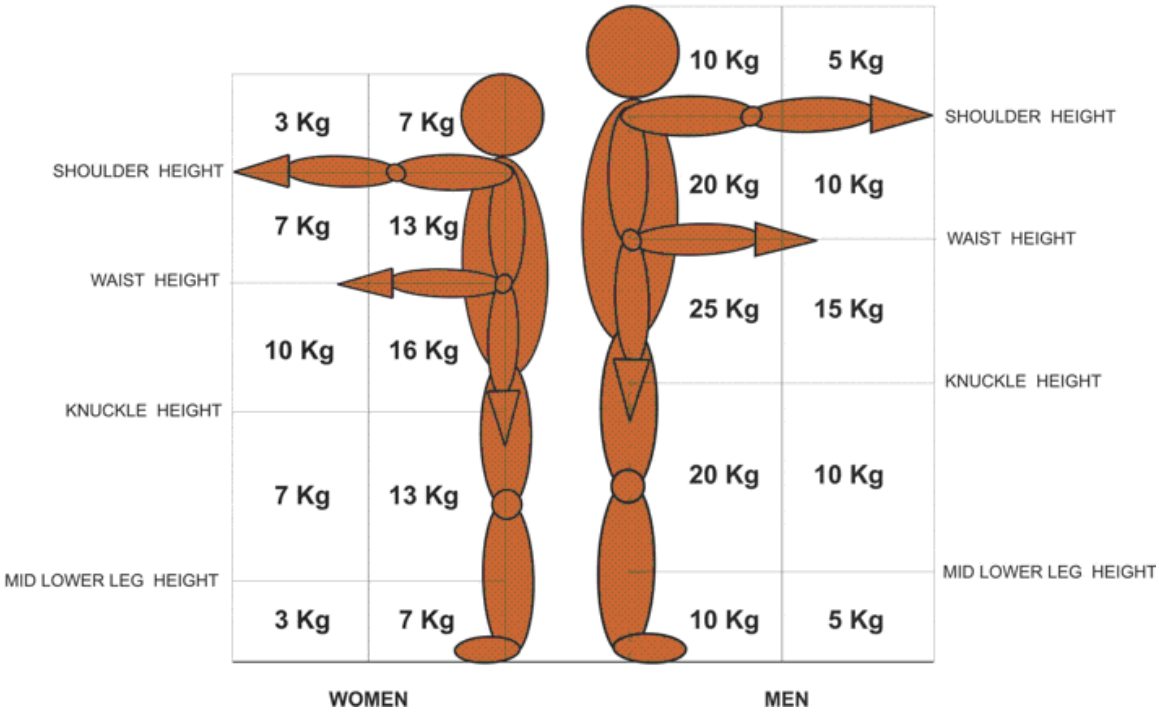
The following points must be considered when making the assessment:

- **The tasks**: do they involve holding the load away from the body, twisting, stooping or reaching upwards, excessive movement or insufficient rest breaks?
- **The loads**: are they heavy, bulky, unwieldy, difficult to grasp, unstable, hot or cold?
- **The working environment**: are there space constraints, uneven or slippery floors, variation in level, extremes of temperature, poor lighting?
- **Individual capacity**: does the job:
    - require unusual strength, height etc;
    - create a hazard to those who are pregnant or have a health problem;
    - require information or training?
- **Other factors**: is the movement or posture hindered by clothing or personal protective equipment?

<u>Some basic tips to prevent accidents</u>:

- Assess the object to be moved. Determine its weight and look for sharp edges. Is the weight evenly distributed?
- Plan the job. Check the route is free of obstacles and slipping or tripping hazards.
- Get help. If you have any doubt about carrying the object then get help. Check that you have suitable tools to help or lifting aids if necessary.
- Get a good grip. Decide in advance how best to hold the object.
- Protect your hands and feet.
- Lift with your legs.
- Avoid twisting, move your feet instead.
- Hold the load close to the centre of your body.
- Minimise lifts above your shoulders or below your knees.
- Avoid becoming over-tired. Frequent lifting or lowering is demanding work and can result in cumulative stress.
- When lifting in a team, work with someone of similar build and height if possible.

GUIDELINE MAXIMUM HANDLING LOADS



15. WORKSTATION AND DISPLAY SCREEN EQUIPMENT

The Health and Safety (Display Screen Equipment) Regulations 1992 apply to employees who habitually use display screen equipment as a significant part of their normal work. A qualified assessor must assess these workstations and DSE.

A number of health problems are attributed to use of DSE. Where problems occur, they are generally caused by the way in which DSEs are used rather than the DSE itself. Some users may get aches and pains in their hands, wrists, arms, neck, shoulders or back, especially after long periods of uninterrupted DSE work. Usually these pains do not last but in a few cases they may become persistent or disabling. RSI is a popular term for these aches, pains and disorders but a better medical name for the whole group of disorders is “upper limb disorders”. Problems of this kind may have a physical cause, but may also be more likely if the DSE user feels stressed by the work.

Problems can usually be avoided by good workplace design and by good working practices. Prevention is easiest if action is taken early, before the problem has become serious.

Tips for setting up and using your computer workstation are as below.

Keyboard

- Separate from screen
- Adjustable tilt
- Keep wrists straight, elbows at 90 degrees and arms parallel to the floor
- Keep it directly in front of you and away from edge of desk

Screen

- Position at a comfortable angle and distance (typically: eyes level with top of screen, screen tilted up slightly and at a distance of about 60cm from eyes)
- Adjust brightness/contrast/distance/angle, if causing eye fatigue
- Position at right angles to windows
- Avoid glare from fluorescent lights (preferably between rows of lights)
- Keep clean

Document Holder (optional)

- At same height, angle and distance from screen, as near to the screen as possible

Desk

- Large enough to allow you to change position
- Wide enough to allow you to sit at a sufficient distance from the screen and to move the keyboard away from the edge of the desk
- Sufficient legroom (no obstructions underneath)

- Uncluttered (keep mouse and telephone close to hand)

Chair

- Adjustable seat height and backrest height and tilt
- Good lumbar support
- Preferably without arm rests
- Adjust to allow feet on floor (or footrest) with hips at right angles
- Back straight and arms at right angle to the desk

Work Breaks

- Recommended 5 minutes away from screen (and other “close” work) per 30 minutes, or 10 minutes per hour (more frequent, shorter breaks are better)
- Alter posture by exercising/getting up and moving around
- Rest eyes by focusing on distant objects

Good Environmental Practice

- Turn off your computer (processor and monitor) when not in use (eg. at lunchtime and overnight)
- If you wish to leave your processor on during lunchtime and short absences from the office, turn off your monitor (it consumes more than half the total power used by your computer)