GUIDELINES FOR GENERAL LABORATORY SAFETY

Policies on Laboratory Safety

Laboratory safety at PolyU is governed by the University's principal Health and Safety Policy and the Laboratory Safety Management Policy. These two policies lay down the management framework and assign duties to various parties in implementing health and safety in the laboratories. Individual departments have the overall responsibility of providing a healthy and safe working environment to their laboratory workers. Each laboratory is unique in its operation and carries its own risk, but there are also many safety issues common to most laboratories. The University also requires laboratory supervisors and research project leaders to take responsibilities to control risk. As a laboratory worker, it is also your responsibility to observe the basic safety rules that have been established to help create a safe and healthy working environment.

This Guideline has been drawn up to provide practical guidance to persons-in-charge and other laboratory users on how to implement health and safety measures as required under the policies mentioned above.

Departmental Health and Safety Structure

The Health and Safety Policy of PolyU requires the Head to appoint a Departmental Health and Safety Officer (DHSO) and to establish a Departmental Health, Safety and Environmental Committee (DHSEC) or alternative means of safety organization.

The DHSO is to advise on health and safety arrangements, liaise with Head, Health, Safety and Environment and ensure the implementation of health and safety arrangements..

The DHSEC is a local forum for discussing health and safety matters as well as environmental protection issues, and for promoting the awareness of those issues among staff and students within the department.

According to the University's Laboratory Safety Management Policy, the Head of Department should also appoint a staff member to be in charge of each individual laboratory. The person-in-charge should:

- assess risks of work activities, work environment and usage of plants and substances under their jurisdiction
- inspect the laboratory to identify and evaluate workplace hazards and unsafe work practices
- inform users of the laboratory about health and safety matters
- establish and maintain good health and safety practices
- follow established guidelines and assist others to meet safety requirements
- report promptly on all accidents/incidents and
- maintain an up-to-date record of documents as required by legislation and by the University.

Safety Induction

Each new employee of PolyU is to go through a safety induction. The new employee safety induction program is to fulfill part of the statutory requirements stated in section 6, 2(c) of the Occupational Safety & Health Ordinance for provision of information, instruction, training and supervision to ensure, so far as reasonably practicable, the health and safety of employees at work. The safety induction program is intended to provide basic health and safety information to the new employee.

The Head of Department, with the assistance of the DHSO, is to ensure all new employees have been provided with Safety Induction so that all new employees are aware of the Health and Safety Policy, as well as departmental health and safety arrangements, procedures and regulations.

The DHSO should arrange for the new employee to be briefed on an individual basis or in groups within TWO weeks of reporting for duty. The induction may be conducted by the DHSO or the supervisor of the new staff member.

Risk Assessment

The objective is to make sure that nobody gets hurt or becomes ill. An assessment of risk is a careful examination of what in your workplace or outcome of your activities could cause harm to people. Having assessed the risk, you can estimate whether you have taken enough precautions to prevent harm. The decision you need to make is whether a hazard is significant, and whether it has been controlled by adequate precautions so that the risk is acceptable.

An example of risk assessment can be given with the use of chlorine gas which is highly toxic. Leakage of a chlorine gas cylinder has, in one particular case, permanently destroyed 70% of the lung function of a research student in the USA so that the injured person is bed-ridden at all times. Leakage is not uncommon in a laboratory if people handle the valve or regulator wrongly. Corrosion of the valve will increase the chance further. The risk is high here. In this example, the laboratory rules and regulations on handling and storage of chlorine gas cylinders must be adhered to strictly to reduce the risk.

On the other hand, household bleach could generate chlorine gas in contact with acid i.e. of the same hazardous nature. However, the chance of mixing is low and the concentration and quantity of chlorine concerned is much less than from a cylinder. Therefore, the risk in using bleach in your home is relatively low.

In general, any risk assessment can be split into five steps:

Step 1 - Look for the hazards

While doing a risk assessment of your workplace, walk around and observe what could potentially cause harm. Concentrate on things that could result in serious harm or affect more than one person. Break down a task step by step, then consider the likely hazards of each step. Talk to people in the laboratory or those who have worked on similar tasks and listen to their complaints or comments. You may reveal issues which are not immediately obvious. Check MSDS or operational instructions issued by manufacturers. These can also help in spotting hazards. Guides from the authorities, accidents and ill health records may give you some hints as well.

Step 2 - Assess who might be harmed, and how

Besides the obvious workers or students in the laboratory, think about people who may be in the workplace for less time, e.g. cleaners, visitors, contractors, maintenance personnel, students, etc. include members of the public, or people you share your workplace with, if there is a chance they could be hurt by your activities.

Step 3 - Evaluate the risks arising from the hazards and decide whether existing precautions are adequate or more should be done

Even after all precautions have been taken, some risk usually remains. What you have to decide for each significant hazard is whether this remaining risk is high, medium or low. Guidelines and standards can usually be found which may give you some idea about the residual risk. Consult the Health, Safety and Environment Office when you are in doubt.

Step 4 - Record your findings for those of significant risk

For high-risk activities, it is worthwhile recording your risk assessment, so that your decisions on the risk and on the action required are documented in case arguments and litigation.

Step 5 - Review your assessment from time to time and revise it if necessary

Any of the following justifies re-assessment:

- a significant change to the type of work
- a significant change to the layout of the workplace
- the introduction of new equipment or new substances/reactions
- the introduction of a new category of person

This would be a frequent task for research work. For routine laboratory work which does not change frequently, the risk assessment on a high-risk process should still be reviewed and revised at least every two years.

There are situations where people may need to work alone in a laboratory. The decision to allow a person to work alone in a laboratory should be based on the risk assessment process.

It is the duty of the course coordinator, principal investigator or supervisor to make a risk assessment and decide whether a person is allowed to work alone on an experiment/process in a laboratory. In general, undergraduates should not normally be allowed to work alone in a laboratory. Postgraduate students and research assistants/associates have to be assessed by their supervisors on a case-by-case basis. Even if allowed to work alone in a laboratory, a second person should remain within shouting distance when the laboratory work is in progress.

Use of Personal Protective Equipment (PPE)

Personal protective equipment (PPE) is any equipment or clothing intended to be worn or held by a person at work, which affords protection against one or more hazards to health or safety. PPE becomes essential in laboratories with hazardous situations where it is not reasonably practicable to reduce the risks by other means. The University has a clear policy on PPE which requires the use of appropriate personal protective equipment as is necessary to ensure the health and safety of staff and students in laboratories. You and your supervisors should assess risk of the research work and laboratory environment to identify the need for bodily protection. The supervisor or the principal investigator should select the appropriate types of PPE for their staff and students according to the risk assessment. The Departmental Health and Safety Officer (DHSO), the designated PPE Control Officer or HSEO should also be consulted on the selection if necessary. The supervisor or the principal investigator should ensure that their staff and students are properly trained in the use of the provided PPE, and that PPE are properly maintained and stored after use.

Users of PPE should:

- make full and proper use of the PPE provided, in accordance with instructions and training received
- take reasonable care of the PPE by cleaning and examining it as appropriate
- report to the supervisor if the equipment is defective or is lost
- store it safely after use.

General Rules and Regulations

Each laboratory is unique in its operation and carries its own risk, but there are also many safety issues common to most laboratories. Below are some of the general safety rules that are applicable to most laboratories.

1. You should know the safety rules and procedures that apply to the work you are doing. Before beginning any new operation, you should determine the potential hazards (e.g., physical, chemical, biological) and the appropriate safety precautions.

2. You should know the location of and how to use the emergency equipment (e.g., fire

extinguishers, safety showers, and eyewash fountains) in your area, as well as how to obtain emergency assistance. Familiarize yourself with emergency response procedures, alarm systems, and building evacuation routes.

3. You should know the types of personal protective equipment available (e.g., hand and face protection) and use the proper equipment for each job. Proper Eye Protectors must be worn as an absolute minimum in laboratories using hazardous chemicals, dangerous machinery, laser equipment or biological agents.

4. You should always be alert to unsafe conditions and actions, and bring them to the attention of your supervisor or the Departmental Health and Safety Officer so that remedial action can be made as soon as possible. There is a strong communication link between Departmental Health and Safety Officers and the Health, Safety and Environment Office. Through these channels you will obtain sufficient professional advice and support. Caring about the health and safety of your fellow workers will be rewarding. Incidents or accidents happening to them may involve you as well.

5. You should not consume food or beverages, smoke or use make-up in areas where chemicals are being used or stored. Glassware or containers that have been used for laboratory operations should never be used to prepare or keep food or beverages. Food storage is not permitted in laboratory freezers, refrigerators, ice chests, or cold rooms.

6. You must fully understand the potential hazards of equipment and substances before you use them. Take the appropriate precautions. For those potentially hazardous substances or equipment that you are not familiar with, refer to the Material Safety Data Sheets (MSDSs), technical manuals or other information sources kept in your department, or consult your supervisor.

7. You should follow established disposal procedures for chemical wastes. Experimental apparatus may require traps or scrubbing devices to prevent the escape of toxic substances into the laboratory and the environment.

8. You should make sure that all containers of hazardous substances (chemicals, biological agents or radioactive substances) are correctly and clearly labelled.

9. You should constantly attend and monitor all experiments involving a heating process. Accidents often happen when heating processes are left unattended. The built-in temperature control of heating equipment such as hot plates and heating mantles should not be overly relied upon. Constant monitoring of the temperature of the heated substances is necessary. When a stable and even temperature is required, a heating bath should be used to replace direct heating. Water baths can be used up to about 80^{o}C. Paraffin is suitable up to about 150^{o}C but is still flammable at high temperatures. Silicone oils can be used for temperatures up to 300^{o}C.

10. You should post warning signs to alert others in the work area when unusual hazards, such as radiation, laser operations, dangerous chemicals, biological hazards, or other special hazards exist.
11. You should remain out of the area of a fire or personnel injury unless it is your responsibility to handle the emergency. Curious bystanders interfere with rescue by emergency personnel, and endanger themselves.
12. You should never distract or startle other workers. Practical jokes or horseplay in the laboratory cannot be tolerated at any time.
13. You should use equipment only for its designed purpose. Inappropriate choice of equipment, such as the use of ordinary glassware for heat-generating chemical reactions, has led to serious accidents before.
14. You should place and handle your reaction apparatus carefully. Do not use excessive force. Plan the experiment so that it is not necessary to move it until the reaction is completed.
15. You should confine long hair and loose clothing when in the laboratory. Shoes must be worn at all times in buildings where chemicals are stored or used. Sandals or open toe shoes are not acceptable.
16. You should not use your mouth to operate pipettes or to start a siphon; a pipette filler should be used.
17. You should avoid exposure to gases, vapours and aerosols. Use appropriate safety equipment and work in a fume hood whenever such exposure is likely.
18. You should always wash your hands and forearms with soap and water before leaving the laboratory area. Washing with solvents can remove the natural protective oil layer from the skin and can cause irritation and inflammation.
19. You should deal with spills of all hazardous substances without delay according to guidelines in other sections of the Health and Safety Guidelines. Potential leaks of any substances, including lubrication oil from vacuum pumps, should be dealt with by using a suitable drip tray as a precaution to contain the spills.

Use of Lasers

Though you may not use lasers in your work, you should still be aware of the potential hazards in order to protect yourself and others. Laser is an acronym for Light Amplification

by Stimulated Emission of Radiation. A laser is an intense, highly coherent, directional and monochromatic beam of light, either visible or invisible.

Lasers are used in research, materials processing, metrology, entertainment, communication, and medical applications. Examples of laser equipment commonly found in PolyU include laser pointers, laser printers, laser surveying equipment, laser welding and cutting machines, laser markers, helium-neon laser guns, etc.

Laser hazards are categorized into beam hazards and non-beam hazards. Beam hazards are associated with the laser radiation itself. The eyes and skin are most at risk to damage from a laser beam.

Different laser wavelengths penetrate to different parts of the eye. The cornea and the lens will focus visible and near infrared laser beams on to the retina where retinal burn may occur. Mid to far infrared and ultraviolet invisible laser beams do not penetrate to the retina, but may cause damage to the cornea which, in turn, may lead to cataracts. High powered lasers may also cause different damage to the skin depending on the laser wavelengths. Actinic ultraviolet may cause erythema and skin cancers while infrared may cause skin burn.

Non-beam hazards result from factors other than direct exposure to a laser beam. These include lethal hazards arising from electricity, chemicals, fire and explosions, etc.

Lasers are commonly categorized into low power, medium power and high power lasers. Different international standards may have different classification schemes. Two of the most common international standards, i.e., the American National Standard (ANSI Z136.1 – 2000) and the International Electrotechnical Commission (IEC) Standard (IEC 60825-1, 2001) classify laser products as follows:

	ANZI	**IEC**
Low power laser	Class 1, 2	Class 1, 1M, 2, 2M
Medium power laser	Class 3A	Class 3R
High power laser	Class 3B, 4	Class 3B, 4

In general, Class 1 lasers are either properly enclosed or have a very low power that is safe. Class 2 lasers are low power products emitting visible laser beams. They are not inherently safe for eyes, but the blink reflex is usually adequate protection. Class 3 lasers are medium to high power products. They may cause eye injury. Class 4 laser products are high power products which may cause skin or eye injury and would constitute a fire hazard.

Each laser product carries appropriate label(s) to international or national standards. Each label includes explanations showing the class of the product, warning symbol (except for Class 1 product) and other information.

There are specific safety requirements for using lasers in PolyU, which are summarised below:

- Registration of laser products – all Class 3B or 4 laser products must be registered with the Health, Safety and Environment Office (HSEO) before use. Safety measures in the operation of the equipment and the building facilities must be in place before registration is accepted.

- Training of users – all users of Class 3B or 4 laser products must be trained in laser safety before they can be authorized by individual departments to operate high power lasers.

- Authorization of users – all users of Class 3B or 4 laser products trained in laser safety must be authorized by individual departments before they can operate the high power lasers.

Details of safety requirements are to be found in the Code of Practice for Laser Equipment.

Use of Ionizing Radiation

Radiation with energy high enough to remove electrons from an atom to create an electrically charged ion is called ionizing radiation. This ionizing process often results in chemical changes in living tissue, which may result in injury to the organism.

Common types of ionizing radiation are:

- Alpha Particles – swiftly moving nuclei of helium atoms carrying positive charges. They have little power of penetration and can be easily stopped by a sheet of paper or the outer layer of skin. However, they are harmful to health once they enter into the body.

- Beta Particles – high speed electrons that are more penetrating than alpha particles. Plastic or aluminium sheet of a few millimetres thick can stop the beta particles effectively.

- X-rays and Gamma Rays – both are electromagnetic radiation having high penetrating power. Dense materials such as lead or concrete are more effective in absorbing these rays.

Ionizing radiation may cause damage to body tissues. However, the effects on health depend on the intensity of the radiation, the length of exposure and the type of body cells exposed. If the entire body is uniformly irradiated by a high dose of radiation in a short time, acute radiation symptoms including nausea, vomiting, extreme tiredness, hair loss or even death may result. Exposure to this kind of radiation may also increase the risks of cancers to the exposed individuals and genetic defects in their offspring.

According to the Radiation Ordinance and its subsidiary regulations (Cap. 303, Laws of Hong Kong SAR), the possession and use of radioactive substances and irradiating apparatus (e.g., X-ray equipment) must be licensed with the Radiation Board.

The safety requirements for using ionizing radiation in PolyU are summarised here:

- Licensing of the radioactive substances or irradiating apparatus – all radioactive substances currently used in PolyU are covered by two licences held by the Health, Safety and Environment Office (HSEO). Users are allowed to use only those radioactive substances listed in the relevant licence at certain specific locations. For irradiating apparatus, the licence is held by each individual department. The use of irradiating apparatus is also limited at specific location stipulated by the licence. In addition, users of open beam X-ray equipment must also be licensed before they can operate the equipment.

- Training of users – all users of radioactive substances and irradiating apparatus must be trained in radiation safety before they can be registered as radiation users.

- Registration of users – only users registered with HSEO are allowed to use radioactive substances or irradiating apparatus.

- Medical examination – users of unsealed radioactive substances are required to prove themselves to be medically fit for radiation work by passing medical examinations for radiation workers. This requirement may also apply to users of other radiation sources upon judgement by HSEO.

- Personal radiation monitoring – users of unsealed radioactive materials should monitor their exposure to radiation by wearing a radiation dosimeter during their work with radiation sources. This requirement may also apply to users of other radiation sources upon judgement by HSEO.

- Warning signs and lights – radiation warning signs must be posted at all radiation areas. Warning lights are also required to be installed at the entrance of room containing open beam X-ray equipment.

Details of safety requirements for using ionising radiation are given in the Code of Practice for Ionising Radiation Protection.

Housekeeping

There is a definite relationship between safety performance and tidiness in the laboratory. Work areas should be kept clean and free from obstructions. Users should clean up after any operation or at the end of each day.

- Wastes should be kept segregated according to their hazardous properties and compatibility, and deposited in designated receptacles.

- Spilled chemicals should be cleaned up immediately and disposed of properly.

- Unlabelled containers and chemical wastes should be disposed of according to the established procedures. Do not allow them to accumulate in the laboratory.

- Do not use stairways and hallways as storage areas for chemicals and never block

access to exits, emergency equipment, or gas and electric switches.

Equipment Maintenance

Equipment such as vacuum pumps, centrifuges, and ovens should be inspected and maintained regularly. The frequency of inspection should be dependent upon the probability and the consequences of failure.
There are certain types of equipment which require regular maintenance and certification, these include pressure vessels and steam autoclaves and steam boilers. New items of these types should be reported to FMO who is responsible for regular examination and certification.

Guarding for Safety

Mechanical equipment should be equipped with guards that prevent access to electrical connections or moving parts, such as, the belts and pulleys of a vacuum pump. In addition to electrical and mechanical guarding, emergency shut-off devices may be needed depending upon the potential hazards involved.

Glassware

Accidents involving glassware are a leading cause of laboratory injuries.

- Careful handling and storage procedures should be adopted to avoid breaking glassware. Damaged items should be discarded or repaired.

- Adequate hand protection should be used when inserting glass tubing into rubber stoppers or corks, or when placing rubber tubing on glass hose connections. All connections of glassware should be polished or rounded.

- Glass-blowing operations should not be attempted unless proper annealing facilities are available.

- Vacuum-jacketed glass apparatus should be handled with extreme care to prevent implosions. Equipment such as Dewar flasks should be taped or shielded. Only glassware designed for vacuum work should be used for that purpose.

- Hand protection should be used when picking up broken glass (small pieces should be swept up with a brush into a dustpan).

- Proper instruction should be provided for first-time users of glass equipment designed for specialized tasks that can present unusual risks.

- Glass reagent bottles with safety designed plastic coating should be purchased, if possible. In case of breakage, the content would be contained by the plastic coating.

Cold Traps and Cryogenic Hazards

Frost-bite is the primary risk in working with cryogenic materials. . The material, its vapor, and the surfaces it cools, can cause burns if allowed to contact the eyes or skin. Gloves and a face shield are needed when using cold traps or cryogenic materials.

Neither liquid nitrogen nor liquid air should be used to cool a flammable mixture in the presence of air because oxygen can condense, leading to an explosion risk.

Dry, insulated gloves should be used when handling dry ice. Avoid lowering your head into a dry ice chest as carbon dioxide is heavier than air, and can accumulate in the chest and cause suffocation.

Systems Under Pressure

Reactions should never be carried out in, nor heat applied to, an apparatus that is a closed system unless it is designed and tested to withstand pressure. Pressurized apparatus should be equipped with relief devices.

Waste Disposal Procedures

The responsibility for establishing waste disposal procedures for routine and emergency situations, and communicating them to you, rests with laboratory management. If you have questions, ask your supervisor or Departmental Health and Safety Officer. According to the requirement of the Environmental Protection Department, all the University waste chemicals will be collected by a licensed collector (Enviropace Ltd.). FMO will co-ordinate the disposal, while HSEO will monitor the standards of your departmental waste disposal practice on a regular basis. Clinical wastes are also collected by a licensed collector managed by FMO.

Unattended Operations

Except where special safety precautions are taken, all laboratory operations (particularly those involving a heating process) should be constantly monitored. Occasionally, laboratory operations are carried out continuously or overnight. It is essential to prepare for possible interruptions in utility services such as electricity, water, and inert gas. Operations should be designed to be safe in case of failure of these services. Wherever possible, you should arrange for periodic inspections of the operation. In all cases, the laboratory lights should be left on and an appropriate sign posted on the door.

One particular hazard frequently encountered is the failure of cooling water supplies. A variety of commercial or homemade device can be used that:

- automatically regulates water pressure to avoid surges that might rupture the water lines; or

- monitor the water flow so that its failure will automatically turn off electrical connections and water supply valves.

Working Alone

Generally, it is prudent to avoid working alone in a laboratory. Under normal working conditions, you should make arrangements with individuals working in separate laboratories, or security guards, to carry out inspections periodically. Do not undertake experiments known to be hazardous when working alone.

Under some conditions, special rules may be necessary. The supervisor of the laboratory has the responsibility for determining whether the work requires special safety precautions, such as having a second person present during a particular operation.

Emergency

When an accident occurs, assistance should be immediately summoned by calling the 24-hour manned Campus Security Control Centre at P111 (Emergency Tel. No.: 2766 7999 or Ext. 7999 on the PABX system or emergency telephone located at strategic areas near your laboratory).

- In case of fire, sound the fire alarm by activating the breakglass alarm switch in the corridor.

- If medical assistance is required during office hours, call the Campus Health Clinic (Tel. No.: 2766 5433 or Ext. 5433 on the PABX system) for advice. If the condition is serious, dial 999 for help at the same time to avoid delay in treatment.

Personnel onsite during the emergency are the key element in ensuring that prompt and efficient action is taken to minimise damage and injury. He or she is also the key person to alert all occupants in the area to evacuate.

The staff reporting the emergency should provide the following basic information:

- the location of emergency
- whether anyone has been injured, is missing or is trapped
- the current situation
- the type(s) of hazards involved and the quantities
- the name of staff in charge of the experiment/work and his/her whereabouts
- whether people in nearby areas have been warned or evacuated
- the location of reporting staff.

Accident Reporting and Investigation

All accidents and incidents must be reported. Staff and students are encouraged to report near-miss incidents so that potential hazards can be identified and eliminated before a more serious accident occurs.

After an incident, the supervisor of the injured person or the staff member responsible for the area in which the accident/incident took place should complete an Accident/Incident Report Form (HSE Form 2) and send it to the Health, Safety and Environment Office (HSEO) through the Head of Department within 72 hours of the accident/incident.

In case of work related accidents involving a member of PolyU staff:

- the University is required under the Occupational Safety and Health Ordinance and Employee's Compensation Ordinance to notify the Commissioner for Labour of any accidents arising out of and in the course of an employee's employment, which results in death or incapacity, either permanent (i.e. disability) or temporary (i.e. sick leave).

- Heads of Department shall inform the Director of Human Resources of such cases immediately after such accidents by completing HR Form 67 and send a copy to Head, Health, Safety and Environment. In such case there is no need to fill in the HSE Form 2.

In the accident reporting process, the concerned Head of Department should initiate an investigation of the case to identify the cause of the incident and whether any remedial action needs to be taken by the department. He or she may seek support from HSEO in conducting the investigation.

Accidents which result in, or which have the potential to inflict serious injury or death, require formal and detailed investigation. In such cases, the Head of Department should appoint a staff member to carry out a joint investigation with HSEO. On the other hand, HSEO may initiate an independent investigation of an accident. The President, his delegate, or the Chairman of the Health, Safety and Environmental Committee may appoint a working group to conduct an investigation of an accident.

Advice and Complaints on Health and Safety Issues

You may obtain professional advice on Laboratory Safety matters by approaching HSEO.