



SULTAN QABOOS UNIVERSITY

HEALTH, SAFETY AND ENVIRONMENT (HSE)

— CODE OF PRACTICE —

June 2014

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VICE-CHANCELLOR'S INTRODUCTION

The activities of our University cover a very wide range of possible hazards to staff and students and to others such as visitors, contractors and the public. It is incumbent on everyone in the University to ensure that our health and safety performance is exemplary. Effective control of risks to people's health and safety maximises their well-being and serves to prevent the consequences of accidents and ill health.

This Statement of Health and Safety Policy and the associated Health and Safety Code of Practice are important legal documents. We are legally obliged to bring this Policy, and any changes to it, to your attention. Beyond that, the information and instructions they contain should be underpinned by a culture which recognises that no activity is so important that it should be pursued in an unsafe manner.

Sultan Qaboos University is committed to achieving high standards of protection of the health, safety and welfare of all those who may be affected by the activities undertaken in the University. The intent of this Code of Practice is to communicate how the University will fulfil this commitment with the help and cooperation of all our staff and students. The Code provides the necessary information and sets out the requirements to ensure that everyone:

- understands the organisation and arrangements for health and safety in the University
- is aware of their own responsibility for health and safety
- knows of and complies with statutory requirements and appropriate codes of practice relevant to their role
- provides any necessary information, instruction, training and supervision to ensure the health and safety of those affected by what they themselves do or by what they ask to have done for them
- sets a high standard of safety by personal example so that students leaving the University take with them an attitude of mind that expects good safety practice as normal

Where there is any doubt about what should be done, you should always seek advice before proceeding. The Statement is being published with the authority of the University Council. Its availability is being communicated to everyone in the University. I ask you to read it and to apply what it says in every way that is relevant to your own particular role.

Dr. Ali bin Saud Al-Bemani

Vice-Chancellor

Sultan Qaboos University

1 STATEMENT OF HSE POLICY

Sultan Qaboos University (SQU) through active participation of all employees, students, visitors, and contractors will strive to manage Health, Safety hazards with the goal of preventing accidents, injuries and occupational illnesses, progressively minimizing environmental impact by reducing discharges and using energy efficiently. SQU recognizes that health and safety are of great importance to the well-being of staff, students and all those who may be affected in one way or another. The responsibility of the University is to provide leadership and to ensure that a clear hierarchy of duties and responsibilities is in place, and is effective, in all aspects of the University's undertaking. SQU expects that everyone in all units under its authority will accept the importance of health and safety in their activities and will co-operate in achieving the highest standards of health and safety. SQU believes that good HSE practice is an integral part of the education process and will contribute to the professional and ethical standing of the University

To ensure achieving the highest level of HSE the SQU will:

- Comply with Sultanate of Oman national HSE policy
- Assign the Vice Chancellor the responsibility for ensuring the effective management of HSE function in the University
- Develop and implement HSE measures to ensure an incident and accident free environment
- Require the SQU administration to uphold strict HSE standards in the workplace
- Develop a high degree-of safety consciousness by ensuring continuous HSE education and training for staff and students
- Maintain regular contact with other HSE organizations to ensure experience sharing and adoption of industry best practice
- Authorize personnel to stop unsafe acts and conditions
- Report and record all near misses, dangerous occurrences, and accidents for subsequent analysis and action
- Investigate dangerous occurrences and accidents to identify the causes and to prevent re-occurrence
- Ensure that regular audit, monitoring, and maintenance of equipment and facilities meet HSE standards
- Ensure strict control of hazardous substances by setting storage, handling, and usage rules to recognized local and international standards.
- Provide adequate resources to maintain and monitor HSE measures
- Develop a forum for staff and student feedback in terms of HSE
- Develop a meaningful incentive for staff, students, and contractors to enhance HSE measures.
- Review the performance and policy periodically, as may be necessary, in light of experience or new legal or regulative requirements or guidance from Authorised Personnel to ensure continuous monitoring, improvement and quality control is maintained.
- Receive and publicize an annual report from Authorised Personnel on the University's performance

SQU will implement this policy through a document describing the Health, Safety and Environmental Management System. All contractors and visitors are required to be committed to and perform their duties according to this policy.

2 HSE MANAGEMENT STRUCTURE AND ORGANIZATION

HSE management functions may be delegated to departmental staff but the responsibility for ensuring that delegated roles are properly executed remains with the senior staff of the University.

The management structure is divided into 9 levels, with following broad duties,

2.1 Level 1: Vice Chancellor

The University Council has overall responsibility for health, safety and environment, which it has delegated to **The Vice-Chancellor**, who is charged with the management of HSE matters in the University. The Vice Chancellor will:

- Ensure that there is a University Health and Safety Policy
- incorporating a Code of Practice which extends to all employees, students, visitors and others who may be affected by the University's undertaking.
- Ensure that the HSE Policy is translated into effective action at all levels in the University.
- Ensure adequate financial provision for putting the HSE Policy into effect.
- Ensure that senior managers in the University are given sufficient training in health and safety matters to discharge their health and safety responsibilities in a competent manner.
- Periodically review the University HSE Policy and make suitable amendments to the organization and arrangements, as necessary.
- Set a high personal example of health and safety standards.

2.2 Level 2: Academic Council

The Academic Council provides consultations to the Vice Chancellor on different HSE matters. The Academic Council will:

- Help in the establishment of an effective organizations structure
- Ensure HSE management system is developed, implemented and maintained for the University
- Support the Vice-chancellor and HSSE Committee in securing sufficient funding to establish, operate and manage an efficient HSE management system in the University
- Review the performance and policy periodically, as may be necessary,
- Review the annual report from HSSE Committee on the University's performance
- Provide feedback to the HSSE Committee on various HSE matters
- Set a high personal example of HSE standards

2.3 Level 3: Health, Safety, Security and Environment Committee (HSSE)

Provides assistance to the Vice-Chancellor in developing, implementing, enforcing and maintaining the HSE management system in the University. Is responsible for the strategic management of HSE matters pertinent to University and implementation of the University HSE policy. The Health, Safety, Security and Environment Committee (HSSE) will:

- Assisting in the formulation of HSE policies.
- Providing HSE related technical services.
- Monitoring the effectiveness of HSE programs.
- Investigating identified hazards.

- Recommending actions to correct safety deficiencies.
- Developing and assisting in implementation of HSE programs.
- Providing training materials, assistance, and programs on HSE work practices.
- Consulting with employees and supervisors about safety and health.
- Operating hazardous waste disposal services.
- Reviewing legislation, recommending policies, and monitoring compliance with environmental health and safety statutes and regulations and University HSE policies and programs.
- Review the performance and policy periodically, as may be necessary, in light of experience or new legal or regulative requirements or guidance to ensure continuous monitoring, improvement and quality control is maintained.
- Disseminating information to university community on legal requirements of appropriate national and university rules and regulations.
- Providing guidance and technical assistance to faculty and staff in colleges, departments, and other work units in identifying, evaluating, and correcting health and safety hazards.
- Acting as the University's official representative with national, regional and international HSE organizations
- Providing staff support to safety committees.
- Authorized to stop any University related activity which is determined to present an unreasonable health and safety risk to University employees and students.
- Liaise with colleges and units HSE Committees on various HSE matters
- Provide consultation and assistance to the vice-chancellor, the academic council, on the strategic planning of HSE management system
- Ensure high HSE standards are maintained in the University
- Review the annual reports on the University's performance
- Promote an interest in and enthusiasm for HSE matters throughout the University.
- Set a high personal example of HSE standards

2.4 Level 4: Heads of Deanships, Centers, Departments or Divisions (Academic) and Director of SQU Hospital

Are responsible for the implementation of the University's Health and Safety Policy in the area under his or her jurisdiction or control, for ensuring adequate resources are made available and that staff under his or her control are appropriately trained. Heads of Deanships, Centers, Departments or Divisions (Academic) and Director of SQU Hospital will:

- Cause the Health and Safety Policy to be implemented throughout the department/centre/school/unit under their control.
- Ensure adequate financial provision is made for health and safety within the area under their control.
- Ensure that all staff and postgraduate students are informed about and provided with access to the Web version of the University Code of Practice for HSE or, alternatively, provided with a hardcopy of the Code of Practice. Supplementary departmental codes dealing with specific hazards shall be supplied to each member of staff and postgraduate students within the department. Undergraduate students are issued with abbreviated HSE code on registration.
- Establish a departmental organization and arrangements for health and safety. Where necessary, e.g. in shared premises, this may include members from other departments. Consultation with HSE Department or Housing Department may be required.

- Ensure that within their area of control that a Departmental Safety Officer (DSO) is appointed, and other key individuals as necessary, to undertake specific departmental safety functions, e.g. supervision of employees or students and research activities, first aid, Display Screen Equipment (DSE) trainers and assessors, Departmental Radiation Protection Supervisor (DRPS), Departmental Biological Safety Officer (DBSO) and Departmental Laser Supervisor (DLS), as necessary.
- Ensure that all hazards are identified and assessed with suitable controls incorporated for activities with significant risk. Also to ensure that all University Health and Safety procedures are correctly implemented, that work is planned, performed and monitored in accordance with statutory provisions, and that assessments are reviewed when there is reason to believe they are no longer valid.
- Ensure that when dealing with or organizing non-routine work tasks, sufficient and suitable health and safety procedures are implemented based on a formal assessment of the risks involved.
- Ensure that all accidents, incidents and work-related diseases and dangerous occurrences are properly investigated and reported to HSSE Committee.
- Where required, ensure that statutory records and registers are maintained and that any plant, equipment or device subject to statutory examination is examined in accordance with regulations. Records must be available for inspection as required and include the Accident Report Book, risk assessments, records of inspection of respiratory protective equipment, radiation records, lifting equipment, pressure systems and local exhaust ventilation.
- Liaise with HSSE Committee and other specialists over major changes to work practices, plant and materials.
- Ensure that suitable Personal Protective Equipment is available and used correctly, that staff and students have received training in its wearing, maintenance and limitations of use.
- Ensure arrangements are in place for portable electrical equipment to be checked and tested at a suitable frequency, and relevant test records kept.
- Set a high personal example of health and safety standards.
- Ensure that they and all staff and students under their control receive adequate training in health and safety matters and are properly trained to perform their roles competently and safely.
- Ensure that records of training are maintained and kept available for inspection.

The following provision should be made:

(a) Awareness and Training

- At the commencement of each academic year, all undergraduates, postgraduates and new staff will receive a short general safety Induction briefing dealing with emergency arrangements and general safety procedures within departments. Relevant topic headings for this Induction briefing will be issued by the HSSE Committee.
- All service personnel and visitors to the Department shall be made aware of relevant provisions of the University Code of Practice whilst on University premises.
- Provision shall be made for staff to attend such mandatory training as is required including Annual fire training for all members of staff and those required to work out-of-hours
- Elementary safety training for those required to work out-of-hours
- An obligatory lecture for staff before commencing work with ionising radiations, or lasers
- An appropriate central training session for anyone wishing to use respiratory protective equipment
- Training for staff defined as Display Screen Equipment "Users".

(b) Supervision of Students

Students must be adequately supervised at all times. This is a legal duty that cannot be discharged by relying solely upon a student's status or competence. Adequate supervision (particularly for postgraduates) does not necessarily mean constant attendance but does require active, regular monitoring of activities. It is the responsibility of the Head of Department to ensure that sufficient Academic and Research staff are appointed to supervise the day to day teaching and research work in their department. A simple scheme for project categorization and determining the level of supervision can be used, such as the one detailed below.

It is the responsibility of the Head of Department to ensure that

- Student projects are properly assessed, for compliance with the law, relevant Codes of Practice, University local rules and existing Departmental safety procedures;
- Any agreed precautions are discussed between the student and supervisor and in all but the most elementary circumstances committed to writing;
- Regular checks are carried out by the supervisor (or suitably qualified and authorized nominee) to ensure that the student is following agreed procedures; and
- The student understands that variations from those procedure must be authorized before further work commences.

Scheme for project categorization:

Category A = Where work may not be carried out without the direct supervision of a specified member of staff, continuously present in the room where the work is being carried out.

Category B = Where work may not be started without the task supervisor's advice and approval which may involve additional training in the procedures involved and in the initial phases of the work, the direct supervision of a specified member of staff continuously present in the room where the work is carried out.

Category C = Where work may not be started without the task supervisor's advice and approval but may be carried out without supervision once additional training in the procedures involved has been carried out.

Category D = Where extra care must be observed but where it is considered that workers are adequately trained and competent in the procedures involved.

Category E = Where the risks are insignificant and carry no special supervision considerations.

For all but the lowest category of work, the Head of Department must ensure that supervisors complete a risk assessment form and that the level of supervision is clearly indicated on that form.

Both the supervisor and the student should sign the form.

Careful thought should be given before a project is authorized for out-of-hours work by a postgraduate student and the general requirements for out-of-hours working must be complied with.

In general, no undergraduate student may carry out experimental work unless under the direct supervision of a member of staff.

Academic and Research Staff shall ensure that they conduct their duties in a safe manner in accordance with the University HSE Code of Practice, any specific codes of practice relating to particular activities and all relevant safety legislation and guidance, that they attend mandatory training in safety matters and that staff and students under their control do likewise. More specifically each member of staff shall ensure that:

- The work of students in their charge is carried out with a minimum of risk and with adequate supervision;
- Student projects are properly assessed for risks, for compliance with the law, relevant Codes of Practice, University local rules and existing Departmental procedures, and appropriate control measures are identified and implemented,
- Appropriate hazardous materials risk assessments are completed for all work with hazardous substances and their recommendations complied with HSE policy and other

risk assessments completed by students must be checked and countersigned by their supervisor.

- Safe working procedures are agreed and recorded. Copies of all relevant safe-working procedures should be provided to the student.
- That suitable Personal Protective Equipment (PPE) is made available and used correctly, that students and staff have received training in its wearing, maintenance and limitations of use. Ensure that defective PPE is replaced as necessary and if defect is found to be a fault of the design or inappropriate usage, to report findings to the Head of Department and HSE Department.
- That the appropriate controls and procedures are implemented, including the wearing of any PPE identified as necessary.
- The student understands that variations from procedures must be authorised by the supervisor before further work commences.
- That all new equipment is safe and that students are trained in its use.
- No undergraduate student is permitted to carry out experimental work (either during the day or out-of- hours) unless under supervision.
- There is a regular schedule of meetings with postgraduate students under their supervision and that arrangements are made for such students to be under the direction of another named academic member of staff if the normal supervisor is absent for any reason.
- For all laboratory-based activities it is determined that –
 - The materials used are necessary and less dangerous substitutes are not acceptable or available;
 - The procedure is being performed in the safest possible way;
 - Appropriate emergency action has been identified, should the activity develop in an unplanned way;
 - The working area is in a safe, tidy and secure condition;
 - There will be no disposal or contamination problems on completion; and
 - On completion of the work, all effects are cleaned up and no unidentifiable materials are left behind to create a potential hazard.
 - Suitable emergency procedures are in place.
- Unless specifically trained to do so, no one attempts to repair or modify electrical equipment or other apparatus belonging to the department.
- That injuries, incidents, work-related diseases and dangerous occurrences are promptly and properly investigated, reported and brought to the attention of other staff and students if relevant.

2.5 Level 5: Heads and Directors of Non-Academic Departments

Are responsible for safety measures at directorate level, for matters for which they have control and assume the employer's responsibility for compliance with the University's Health and Safety Policy, relevant legislation and Approved Codes of Practice and Guidance. They will:-

- Cause the University HSE Policy and Code of Practice to be translated into effective action at all levels for matters for which they have control.
- Make adequate financial provision for putting the Policy into effect.
- Cause the Health and Safety performance in the areas under their jurisdiction to be monitored and reviewed.
- Promote an interest in, and enthusiasm for, Health and Safety matters in the University.
- Ensure that managers are given adequate training in HSE matters to competently discharge their responsibilities.
- Set a high personal example of health and safety standards.

2.6 Level 6: Health, Safety, Security and Environment Committee

Is responsible for managing HSE matters and ensuring high standard of HSE is maintained in the workplace.

- Enforce all safety rules and regulations to ensure high HSE standards are maintained.
- Review and revised, as needed safety rules and regulations.
- Reviews accident reports and makes appropriate recommendations to the department Chairperson regarding proposed changes in the laboratory procedures.
- Performs laboratory inspections to ensure departmental compliance with departmental, university, state, and federal regulations.
- Liaise with College, Centre or unit ,the University HSSE committee and HSE Department in all HSE matters
- Provide consultation to the chairperson on various HSE matters
- Represent College, Centre or unit staff views in various HSE matters
- Set a high personal example of HSE standards

2.7 Level 7: Academic and Research Staff, Laboratory and Departmental Superintendent or Director or Office Director

Is responsible for ensuring the safe conduct of activities in laboratories, workshops, workrooms, offices, etc., that equipment is safe to use, and that safe practices, procedures and techniques are adopted and maintained. They will ensure that:

- The University Health and Safety Policy will be implemented throughout their area of control.
- Technical staff under their supervision are provided with appropriate information, are adequately instructed in general safety matters and are fully aware of their departmental duties.
- All staff under their control are adequately trained in the specific safety measures appropriate to their job and that they attend all such safety training as may be required.
- All staff under their control are supervised to a level which is appropriate to their level of competency.
- When dealing with non-routine work tasks sufficient and suitable health and safety procedures are implemented based on a formal assessment of the risks involved.
- All accidents, incidents and work-related diseases and dangerous occurrences are properly investigated and reported.

2.8 Level 8: Employees and Students

All staff are legally required to conduct themselves at all times so as not to endanger their health and safety or that of any other person who may be affected by their acts or omissions. They must comply with all relevant health and safety requirements and follow the rules and guidance from levels 2 and 3 to 7.

Students are required to conduct themselves similarly, and sign a declaration to do so.

The Head of HSE Department provides specialist expertise and advice to levels 1 and 3 and have the appropriate and necessary information on health and safety matters to enable them to fulfill their roles and exercise effective control over the management of health and safety in the University. HSE Department will monitor performance of all levels against the policy objectives and produce reports and information of its findings. Systematic HSE auditing will also be instigated at this level. Each group reports its findings to the HSE Committee, which decides what action is appropriate.

Employees: By law everyone has a safety responsibility. It is important that everyone appreciates the extent of that responsibility. When any employee or student has control over activities in an area, they must comply with the University's Health and Safety Policy and Code

of Practice, plus any other specific Codes of Practice and guidance relevant to their particular activities. In particular it is the duty of every person while at work:

- To take reasonable care for the health and safety of themselves and of all other persons who may be affected by their acts or omissions at work. Students, whether undergraduates, postgraduates, and all other persons legitimately on University premises are required to conform to the standards demanded of all employees.
- To co-operate with the Heads of Department and any other persons having specific safety duties, so that they can comply, so far as is necessary, with relevant health and safety legislation, codes etc, and with the University's Health and Safety Policy; and
- Not to interfere with or misuse, intentionally or recklessly, anything provided in the interests of health, safety or welfare.
- Attend all mandatory safety training.

Postgraduate Students: shall ensure that they conduct their duties in a safe manner, in accordance with the University HSE Code of Practice or any specific Codes of Practice relating to their particular activities and all relevant safety legislation and guidance. In addition they shall:

- Ensure that before commencing any experimental research work, health and safety requirements and precautions and any special hazards are discussed with their supervisors;
- Ensure that their supervisor checks and countersigns risk assessments prior to commencing practical work;
- Unless specifically authorized to do so, not attempt to repair or modify any electrical equipment or other apparatus belonging to the department.

Undergraduate Students: shall ensure that they conduct their work in a safe manner, in accordance with the University HSE Code of Practice, an abbreviated version of which will be issued to them. In addition all undergraduate students shall:

- comply with all safety instructions, oral and written, given to them, including any part of the main Code of Practice which is drawn to their attention by a member of staff;
- never enter a laboratory, workshop or storeroom unless authorized to do so;
- never use any material, equipment or facility without having first been given specific instructions on the operations to be performed and the precautions to be adopted by the tutor or supervisor, and
- never attempt to repair or modify any apparatus belonging to the department without the permission of a member of academic staff. Faulty or damaged equipment shall not be used and should be brought to the attention of a member of the academic staff or senior technical staff.

3 EMERGENCIES

3.1 Introduction

An emergency is a situation that requires an immediate response to prevent loss of life or property. During your work in the university there is always the risk of an emergency situation occurring. The emergency can be the result of a:

- Chemical spills
- Biohazard spills
- Radiological spills
- Medical emergency
- Fire

All colleges should develop their own written emergency response plans and all employees should be trained and participate in drills so that the plans are efficiently carried out in the event of an emergency.

3.2 Chemical Spills

In spite of the best efforts one makes to prevent laboratory spills, spills happen. Although most spills are small and easily handled, some may disrupt operations in the college because they require the laboratory or even the entire building to be evacuated.

To prepare for laboratory spills, anybody working in a laboratory should learn about the hazards of the chemicals used in that laboratory. Written procedures on how to address such hazards should be made available to staff and necessary training provided. The cleanup of a chemical spill should only be performed by personnel familiar with the chemicals involved.

Chemical spills are generally classified into two: major/emergency spills and minor spills.

3.2.1 Major/Emergency Spills

A chemical spill is classified as a major/emergency spill whenever:

- The situation is unfamiliar/unclear to the person causing or discovering the spill.
- It causes personal injury or chemical exposure that requires medical intervention.
- It involves or poses a threat of fire, explosion, uncontrollable volatility or other imminent danger.
- It requires breathing apparatus to be used.
- It involves or contaminates a public area.
- It requires laboratory or building evacuation.
- It cannot be controlled or isolated by laboratory personnel even if they are trained.
- It cannot be properly handled due to lack of local trained personnel and/or equipment to perform a safe, effective cleanup
- It involves any quantity of metallic mercury.
- It involves an unknown substance.

The following are the steps to follow whenever a major/emergency spill occurs. It's important to remember that each spill incident is unique and involves persons with varying levels of spill expertise and experience. Thus, for any individual incident, isolation of the spill and/or securing the area might be the best practice prior to or simultaneously with contacting the department safety officer.

If the substance involved is known:

- Don't panic!
- Contact the Laboratory Safety Officer (LSO) indicating location of the spill and the chemical spilled.
- Do not touch the spill without protective equipment's.
- Never assume gases or vapors do not exist or are harmless because of lack of smell.
- Reduce the vapor concentrations if any and the enlargement of the spill area by covering the surface of a liquid spill with absorbent.
- Increase ventilation by opening closed fume hood sliding glass door to the full open position. Exterior doors may be opened if non-toxic vapors.
- If flammable vapors are involved, do not operate electrical switches unless to turn off motorized equipment. Try to turn off or remove heat sources, if safe to do so.
- If the spill presents an immediate danger, follow the same as for unknown chemical (next section) even if you are trained to clean-up spills.
- Protect yourself, and then remove injured person(s) to fresh air, if safe to do so.
- Notify nearby persons and evacuate as necessary. Prevent entry, as necessary, by posting a guard in a safe area and/or shutting doors.

If the substance involved is an unknown chemical, the emergency spill response procedures are limited to self-protection and protection of personnel working in the area.

- Stop work
- Close doors to the laboratory where the spill occurred and shut-off electrical equipment as you leave
- Evacuate the personnel from the spill area using the nearest fire exit. Do not use the elevator.
- Call 4444, civil defense, to report the spill , Make sure you provide all spill information.
- Block off the area's leading to the spill until the arrival of the civil defense.
- Do not go back to the spill area until told to do so.

3.2.2 Minor Spills

A chemical spill is classified as a minor spill whenever:

- Small quantities of known chemicals are involved.
- The person causing or discovering the spill understand properties of the chemical involved and can make an estimation of the exposure level.
- The chemical involved present only minor safety and health hazard to persons in the immediate work area or those assigned to clean-up.
- The spill can be appropriately cleaned-up by laboratory personnel using available spill skit.

The following general procedures should be used for all minor spills:

- Attend to any persons who may have been contaminated.
- Notify persons in the immediate area about the spill.
- Evacuate all nonessential personnel from the spill area.

If the spilled substance is flammable:

- Turn off ignition and heat sources.
- Avoid breathing vapors of the spilled material.
- Leave on or establish exhaust ventilation if it is safe to do so.
- Put on appropriate personnel protective equipment.

If the spill is liquid:

- Confine or contain the spill to a small area. Do not let it spread.
- For inorganic acids or bases, use a neutralizing agent or an absorbent mixture (e.g., soda ash or diatomaceous earth).
- For other materials, absorb the spill with a non-reactive material (such as vermiculite, clay, dry sand, or towels).
- Mop up the spill, then clean the area with water.
- Decontaminate the spill clean-up equipment with copious amounts of water.

If the spill is solid:

- Collect the spilled solids using a broom and a dust pan and place them into a container suitable for that chemical; Use a vacuum cleaner if available.
- Dispose of residues according to safe disposal procedures.
- Decontaminate the spill clean-up equipment with copious amounts of water.

3.2.3 Mercury Handling and Spill Clean Up

Mercury is volatile and poisoning from exposure by chronic inhalation can cause emotional disturbance, unsteadiness, inflammation of the mouth, fatigue, memory loss, and headaches. In most cases of exposure by chronic inhalation, the symptoms of poisoning gradually disappear when the source of exposure is removed. However, recovery may be slow and may take years. Because of these mercury health effects, **every effort should be made to prevent accidents involving mercury**.

3.2.4 Mercury Storage and Handling

- Store mercury in unbreakable containers and in a well-ventilated area.
- Transfers of mercury from one container to another should be carried out in a hood, over a tray or pan to confine any spills.
- Use of mercury thermometers should be avoided.
- If a mercury thermometer is required, use the one with a Teflon coating that prevent shattering.
- Always wash hands after handling mercury to prevent skin absorption or irritation.

3.2.5 Air Monitoring

Mercury spills have the potential to generate vapour levels in excess of permissible levels. Ask your Laboratory Superintendent for advice before any mercury handling operations. In large spill situations a qualified contractor may be necessary to perform the clean-up.

3.2.6 Protective Clothing

For small spills, a laboratory coat, safety glasses, and specific gloves for protection against elemental mercury (see Appendix B) should be used.

If mercury has been spilled on the floor, plastic shoe covers should be worn. **Note:** Whenever mercury is used in laboratory a spill kit should be made available. See the mercury spill kit content in Appendix B .

3.2.7 Clean-up procedure

If the mercury kit has been purchased, follow the provided procedure with the kit otherwise, use the following steps.

- Assemble the pools and droplets of mercury and then collect them by a suction pump.
- Sprinkle the entire area with zinc powder and spray the zinc with the dilute sulphuric acid.
- Using a sponge, work the mixture zinc powder and sulphuric acid into a paste consistency while scrubbing the contaminated surface.
- When the paste is dry, swept it up and place into the plastic container for disposal.

- Gloves, shoe covers, sponges, and anything used for the cleanup should be placed in the trash bag to be disposed of as contaminated material.

3.2.8 Mercury Waste Disposal

Call the Waste Disposal Committee Chairperson (see Error! Reference source not found. for contact information) for advise on how to deal with the mercury waste and contaminated items.

3.2.9 Documentation

After any chemical spill, regardless of its size, it should be reported to the corresponding College Safety and Security Committee. The report should include:

- Date and time the spill occurred
- Location
- Chemical(s) involved and their volume
- Names and contact details of all persons involved including:
 - ✓ Personnel involved in the clean up
 - ✓ Visitors that may have been exposed

The report should document what happened, why, what was done and what was learned.

3.3 Biohazard spills

All laboratories involved with infectious agents or biohazard materials should develop detailed spill procedures specific their biohazard level and should have a ready spill kit. The following procedures should be used as a guide for the preparation of your department procedures.

3.3.1 Spills occurs Outside the Biological Safety Cabinets (BSCs)

Spills outside BSCs may generate aerosols that can be dispersed in the air throughout the laboratory. These spills can be very serious if they involve microorganisms that require Biosafety Level 3 containment. **To reduce the risk of inhalation exposure in such an accident, occupants should leave the laboratory immediately. The laboratory should not be re-entered to decontaminate or clean up the spill for at least 30 minutes** to allow for the removal of the aerosols via the exhaust ventilation systems

The decontamination and cleanup procedures for biohazard spills vary accordingly to the biosafety level of the organism involved.

3.3.2 Biosafety Level 1 Organism Spill

- Wear disposable gloves.
- Soak paper towels in disinfectant and place over spill.
- Place towels in a plastic bag for disposal.
- Clean up spill area with fresh towels soaked in disinfectant.

3.3.2.1 Biosafety Level 2 Organism Spill

- Alert people in immediate area of spill.
- Put on protective equipment. This may include a laboratory coat with long sleeves, back-fastening gown or jumpsuit, disposable gloves, disposable shoe covers, safety goggles, mask or full-face shield.
- Cover spill with paper towels or other absorbent materials.
- Carefully pour a freshly prepared 1 to 10 dilution of household bleach around the edges of the spill and then into the spill. Avoid splashing.
- Allow a 20-minute contact period.
- After the spill has been absorbed, clean up the spill area with fresh towels soaked in disinfectant.

- Place towels in a plastic bag and decontaminate in an autoclave.

3.3.2.2 Biosafety Level 3 Organism Spill

- Attend to injured or contaminated persons and remove them from exposure.
- Alert people in the laboratory to evacuate.
- Close doors to affected area.
- Call the Laboratory Safety Officer

3.3.2.3 Spills on the Body

- Remove contaminated clothing.
- Vigorously wash exposed area with soap and water for one minute.
- Obtain medical attention (if necessary).
- Report the incident to the department Safety Officer

3.3.3 Blood Spills

Universal precautions must be observed (for more detail see Error! Reference source not found.).

- If an untrained person encounters a spill, he/she should limit access to the area and immediately call the person(s) assigned to this duty.
- If a spill involves broken glassware, the glass should never be picked up directly with the hands but using a brush and dustpan, tongs, or forceps.

3.3.3.1 Personal Protective Equipment

- Disposable gloves should be worn when cleaning blood spills
- Disposable gloves must never be washed or reused.
- Double-bag used gloves with other contaminated waste (such as towels).
- If there is a risk of splashing during cleaning, call an expert to assist. Additional protective equipment may be required (e.g. face-shield, plastic apron).

3.4 Radiation spills

Emergencies generally occur as a result of spills, fires, or explosions which cause radioactive materials to be released. In the event of such events, the following general procedures are given as a guide and to be adapted to the specific nature of the emergency.

3.4.1 Minor Spills involving no radiation hazard to personnel

- Notify all other persons in the room at once.
- Permit only the minimum number of persons necessary to deal with the spill into the area.
- Confine the spill immediately.

3.4.1.1 Liquid spills

- Put on protective clothing.
- Drop absorbent paper on the spill.

3.4.1.2 Dry Spills

- Put on protective gloves.
- Dampen thoroughly, taking care not to spread the contamination.
- Notify the faculty member in charge of the laboratory and the Radiation Safety Officer as soon as possible.

- Monitor all persons involved in the spill and cleaning.
- Decontaminate the area according to the available procedure (see Appendix B)
- Permit no person to resume work in the area until a survey is made, and approval of the Radiation Safety Officer is secured.
- Prepare a complete report of the accident to be handed to the Radiation Safety Office. A copy of the report should be kept with the Safety Office of the involved department.

3.4.2 Major Spills Involving Radiation Hazard to Personnel

- Notify all persons not involved in the spill to vacate the room at once and if the product is volatile also notify everybody else in the College (the AC is common to all of the College).
- If the spill is on the skin, flush thoroughly.
- If the spill is on clothing, discard outer or protective clothing at once.
- Shut off air conditioning units serving the laboratory.
- Vacate the room.
- Notify the faculty member in charge and the Radiation Safety Officer as soon as possible.
- Take immediate steps to decontaminate personnel involved, as necessary.
- Decontaminate the area per the recommendations of the Radiation Safety Officer. (Personnel involved in decontamination must be adequately trained and protected.)
- Monitor all persons involved in the spill and cleaning to determine adequacy of decontamination.
- Permit no person to resume work in the area until a survey is made and approval of the Radiation Safety Officer is obtained.
- Prepare a complete report of the accident to be handed to the Radiation Safety Officer. A copy of the report should be kept with the Safety Office of the involved Department.

3.4.3 Accidents Involving Radioactive Dusts, Mists, Fumes, Organic Vapors, and Gases

- Notify all other persons to vacate the room immediately.
- Hold breath and vacate room.
- Shut off air conditioning by master switch.
- Notify the faculty member in charge of the laboratory and the Radiation Safety Officer at once.
- Ascertain that all doors giving access to the room are closed.
- Post warnings or guards to prevent accidental opening of **doors**.
- Report at once all known or suspected inhalations of radioactive materials.
- The Radiation Safety Officer shall evaluate the hazard and the necessary safety devices for safe re-entry.
- Determine the cause of contamination and rectify the condition.
- Decontaminate the area.
- Perform air survey of the area before permitting work to be resumed.
- Monitor all persons suspected of contamination.
- Prepare a complete report of the accident to be handed to the Radiation Safety Office. A copy of the report should be kept with the Department Safety Officer.

3.4.4 Handling of Injuries to Personnel Involving Radiation Hazard

- Wash minor wounds immediately, under running water, while spreading the edges of the gash.
- Report all radiation accidents to personnel (wounds, overexposure, ingestion, and inhalation) to the faculty member in charge and the Radiation Safety Officer as soon as possible.
- Call for medical help (**Ext: 4777 or direct number: 24144777**)
- Permit no person involved in a radiation injury to return to work without the approval of the Radiation Safety Officer and attendant physician.
- Prepare a complete report of the accident for the records of the Radiation Safety Officer.

3.5 Leaking Compressed Gas Cylinders

Occasionally, a cylinder or one of its component parts develops a leak. Most such leaks occur at the top of the cylinder in areas such as the valve threads, safety device, valve stem, and valve outlet.

- If a leak is suspected, do not use a flame for detection; but use a flammable-gas leak detector or soapy water. .
- If the leak cannot be remedied by tightening a valve gland or a packing nut, emergency action procedures should be taken.
- Never attempt to repair a leak at the valve threads or safety device; consult with the supplier for instructions.
- If the substance in the compressed gas cylinder is not inert, or is hazardous, use the procedures for "Chemical Spills".
- If the substance in the compressed gas cylinder is inert, or non-hazardous, contact the supplier for instructions.

3.6 Fires

Fires are a common emergency in laboratories particularly in chemistry laboratory.

3.6.1 Fire action

If you discover a fire you should:

- Activate the nearest fire alarm
- Tackle the fire **ONLY** if the fire is very small and if you have been trained to handle it safely.
- **Call 4444 (Civil Defense).** It is critical to provide the Civil Defense Center with the following information:
 - Building name (e.g. college of Sciences)
 - Location of the fire in the building (e.g. Chemistry department on the 2nd floor)
 - Evacuate the building as in paragraph **5.0**.

3.6.2 Fire evacuation procedures

3.6.2.1 If you hear the alarm:

- Stop working immediately.
- Switch off any electrical systems, open flames, and equipment you are working with.
- Vacate the building using the nearest fire exit even if someone else tells you it is a false alarm.
- Never stop to collect personal belonging.

- Close the door behind you, if you are the last one to leave the room.
- Never use a lift, use stairs, and keep to your right.
- Go to the assembly point as shown on your College evacuation map.
- Never re-enter the building until you have been given the “all clear”

Note: If an occupant is unable to evacuate from the 1st or 2nd floor, he/she must proceed to the closest and safest area then inform the Civil Defense (**Ext: 4444 or direct number: 24144444 / or 9999**) of his/her location and that he/she is unable to leave the facility.

3.6.2.2 *If you are caught in smoke*

- Drop to hands and knees and crawl towards the nearest exit.
- Stay low as smoke will rise to ceiling level.
- Hold your breath as much as possible; breathe through your nose and use a filter such as a shirt or towel.

3.6.2.3 *If clothing on fire: Stop, Drop, Roll*

- Roll person around on floor.
- Cover person with a fire blanket, if available.
- Call for medical help (**Ext: 4777 or direct number: 2414777**).

Note: All fires must be reported to the SQU Safety and Security Committee and be investigated by the College Fire Safety Officer to prevent recurrences.

3.7 Medical Emergencies

Personal injuries are not uncommon in laboratories. Prevention of injuries should be a major emphasis of any laboratory safety program. Proper training will help prevent injuries from glassware, toxic chemicals, burns and electrical shock.

Personal injuries are usually minor cuts or burns but can be as severe as acute effects of chemical exposure or incidents such as heart attacks or strokes.

In the event of such an emergency, first aid rests with the first person(s) at the scene. He/they should react quickly but in a calm and reassuring manner (see First Aid procedures in next section).

The person assuming responsibility should immediately

- Call for medical help by calling for an ambulance (**Ext: 4777 or Direct number: 24144777**) and report suspected types of injury or illness, location of victim.
- Send people to meet the ambulance crew at likely entrances of the building.

Note: To prevent further injury, the injured person should not be moved except where necessary.

The names of persons in your area trained in CPR and First Aid as well as the number to call for medical emergency should be posted by the telephone of all laboratories.

All first aid, chemical exposures, and medical emergencies should be reported (See Error! Reference source not found. Accidents reporting).

3.8 First Aid

3.8.1 Introduction

- First aid is the first treatment that is given to an injured or sick person before professional medical treatment is available. In some situations such as minor cuts small burns, scratches etc., this first intervention may be sufficient.
- First aid kit should be readily available in each laboratory as well in other populated areas in the colleges.

- It is recommended that each laboratory have at least one or better two persons trained in basic first aid and cardiopulmonary resuscitation (CPR) and have at least one automatic external defibrillator (AED) and all staff should receive a proper training on how to use it.
- Phone numbers of emergency services should be clearly posted.
- The injured person should always be accompanied to the medical facility by someone knowledgeable about the accident
- Minor injuries requiring first aid should always be reported to a supervisor and recorded on an Injury Form (see Appendix C) which must be submitted to the Safety Officer. Reasons for this are as follows.
 - A minor injury may indicate a hazardous situation which should be corrected to prevent a serious future injury.
 - It is important to document a minor injury as having been "work related" if the injury later leads to serious complications, such as from an infected cut.

3.8.2 General procedures

- Protect the victim from further injury (e.g. extinguish burning clothing, cut off the current shocking the victim)
- Do not move the victim unless she is in further danger.
- Call 4777 for immediate assistance.
- If you are first aid trained restore and maintain breathing and heartbeat and administer any necessary first aid.
- Keep the person warm to prevent shock.
- Do not give anything to drink.
- If the victim is taken to A&E, a staff member should go with her.

3.8.3 Thermal burns

Burns are classified accordingly to the depth of skin damage. First and second degree are superficial. However, the third and fourth degrees affect the deep layers of the skin and may lead to serious infections

- Do not remove any cloths adhering to the skin.
- Douse the burn area with plenty of cold water for at least 10 minutes
- Call 4777 for an ambulance.
- Continue cooling the area until the pain is relieved.
- Cover the burned area with the cleanest available cloth material.
- Keep the victim warm. Because shock is very serious complication in burns.
- If burn in the face, do not cover the face; you may block the airways.

3.8.4 Chemical Accidents

3.8.4.1 Chemical splash in the eye

- Flush the open eyes immediately with plenty of water for at least 15 minutes.
- If contact lens remove then if easy to do so.
- Get medical attention as soon as possible.

3.8.5 Chemical spill on the skin

- Flush the area immediately with plenty of water for at least 15 minutes
- Remove contaminated clothing, or jewellery from the affect body part taking care not to spread the chemical to other part of the body or the eyes.
- Do not apply chemical neutralizing agents except in case of Hydrofluoric acid splash, apply calcium gluconate gel
- Obtain medical care immediately.

3.8.5.1 Inhalation of chemicals

- Remove quickly the person from the contaminated area.
- If victim is not breathing, if you are trained, begin CPR.
- Call 4777 (or 24144777) for assistance.

3.8.6 Personal Protection During First Aid

- Assume that all patients are infectious for HIV and other blood-borne pathogens and use "Universal Precautions" (see Appendix.....).
- If possible, use personal protective equipment (i.e., gloves, masks, and protective clothing). when dealing with blood or other body fluids
- After emergency care has been administered
 - Wash hands and other skin surfaces immediately and thoroughly with warm water and soap if contaminated with blood, other body fluids
 - Wash always hands after gloves are removed, even if the gloves.

4 SAFETY RULES

4.1 General Work Habits and Safety Practices

Following the correct safety procedures and using the right protective equipment are professional obligations — failing to do so not only jeopardizes your safety, but also reflects negatively upon the image of the university.

- Before commencing any job take the time to look at the layout and condition of the work area to determine if you are able to do the job safely — if there is any doubt about safety, consult with your supervisor/safety officer before commencing.
- Always report unsafe conditions or activities to your supervisor/safety officer as soon as possible.
- Report any accident or injury to your supervisor/safety officer without delay and attend to getting the necessary first aid or medical treatment immediately.

4.2 Personal Protective Equipment (PPE)

Eliminating a hazard through engineering or administrative controls, such as fume hoods, is the primary and preferred method of providing personal protection. In addition, skin, eyes and respiratory tract should be protected by use of appropriate laboratory clothing, eye protection and, if necessary, respirators.

Laboratory supervisor/safety officers are required to assess the hazards based on the procedures performed in the laboratory and the controls in use. If they identify that PPE is required, the University must provide personal protective equipment (PPE) at no cost to the employee and students. PPE for some types of hazards are shown in the following table (Table 4-1).

Table 4-1 Hazards and PPE

HAZARD	PERSONAL PROTECTIVE EQUIPMENT
Biohazards (Germs)	Splash goggles, respirators, gloves, surgical masks, lab coats, aprons, sleeves, shoe covers, head covers
Chemicals	Gloves, chemical-resistant clothing, aprons, sleeves and shoe covers, vapor-proof or splash goggles, respirators
Cuts/Abrasions	Cut-resistant gloves (leather, Kevlar, chain-mail)
Dust	Dust goggles, respirators
Electricity	Electrically-resistive gloves, mats, hard hats
Falling Objects	Hard hats, steel-toe shoes, metatarsal guards
Falls	Fall harness, strap-on hard hat
Flying Particles	Safety glasses with side shields, goggles, face shields
Hot Environments	Cooling vests, reflective suits
Hot or Cold Objects	Gloves (Note: Asbestos gloves are prohibited and must be turned in as hazardous waste.)
Intense Light	Opaque glasses, goggles, welding hoods
Kneeling	Knee pads
Lifting	No PPE available, use engineering controls/training
Low Overhead Objects	Bump cap, hard hat
Noise	Hearing protectors
Over-Water Work	Life vests, flotation devices
Radiation	Lead apron, lead gloves, thyroid collar, lead glasses for X-ray, lab coats/gloves for radioactive materials
Repetitive Motion	No PPE available, use engineering controls/training
Slipping	Non-skid shoes
Splashes	Splash goggles, face shields, chemical-resistant clothing, gloves, aprons, sleeves and shoe covers
Traffic	Reflective vest

The supervisor/safety officer must also instruct employees in how to select, inspect, use, maintain, and store the PPE.

The laboratory should have extra PPE available for loan to visitors if they will be allowed to participate in the experimental procedures or if general laboratory rules require that all personnel will wear the specified PPE.

4.2.1 Eye Protection

Appropriate eye protection must be worn when working with chemicals. Avoid use of contact lenses in the laboratory. If you wear contact lenses, notify the laboratory supervisor/safety officer and always wear chemical splash goggles or a face shield.

4.2.1.1.1 Prescription Safety Glasses

Prescription safety glasses may be available from optical stores. Do not use regular glasses as safety glasses; they are not strong enough.

4.2.1.1.2 Safety Glasses

Safety glasses with side-shields are designed to provide impact protection but provide little protection from chemical splashes, dusts, or hot particles.

4.2.1.1.3 Splash Goggles

Splash goggles with splash proof sides should be worn when there is a danger of a chemical splashing. Goggles that have screened sides or other vents, are not splash proof, but can be worn when working with apparatus that could produce flying particles (e.g. glassware under reduced or elevated pressure).

4.2.1.1.4 Face Shields

Face shields in addition to safety glasses or splash goggles provide maximum protection to the face and neck from flying particles and harmful liquids. Face shields also may be needed when a vacuum system is used.

4.2.1.1.5 Free Standing Barrier Shields

Free-Standing barrier shields can be used to protect yourself and bystanders from possible explosion.

4.2.1.1.6 Specialized Eye Protection

Specialized eye protection is needed when working with intense light sources such as infrared light, ultraviolet light, glassblowing, welding, and lasers. Glasses, goggles, or face shields with adequate filtration are needed.

4.2.2 Apparel

4.2.2.1 Inadequate Clothing

In the laboratory, do not wear open-toed shoes, sandals, shorts, nylon hose, cropped tops, or any other apparel that leaves skin exposed and unprotected. All loose clothing should be confined to avoid easily catching fire, dipping into chemicals, or becoming entangled in moving machinery.

4.2.2.2 Jewelry

Remove jewelry to prevent chemicals from collecting underneath, contacting electrical sources, catching on laboratory equipment, and/or damaging the jewelry itself.

4.2.2.3 Hair

Long hair should be tied back or confined to avoid easily catching fire, dipping into chemicals, or becoming entangled in moving machinery.

4.2.2.4 Lab Coats, Aprons and Sleeves

- 1) Laboratory coats or aprons and sleeves should be worn whenever there is a danger of contaminating skin or clothing. Clothing made from chemical-protective fabrics should be used as needed. Contaminated personal clothing may spread hazards to family and friends, as well as contaminate public areas such as doors, hallways, elevators and food services.
- 2) Lab coats should be removed before leaving the laboratory.
- 3) Contaminated laboratory coats should be laundered through the University Consolidated Laundry or similar industrial laundry service.

4.2.3 Gloves

4.2.3.1 When to Wear

Wear gloves whenever working with chemicals, rough or sharp-edged objects, or very hot or very cold materials.

Do not wear gloves around an unguarded, moving machine as it could snag the glove and pull your hand into it.

4.2.3.2 Selection

Select gloves based on the material being handled, the particular hazard involved, and their suitability for the procedures being conducted (such as whether the glove provides appropriate dexterity for the procedures). Other types of gloves used in a laboratory may be designed to protect from biological hazards, sharp objects, and temperature extremes, among other hazards. Asbestos gloves are prohibited and any found in a laboratory should be turned in as hazardous waste.

4.2.3.3 Inspection

Inspect gloves before each use and discard if you see discoloration, punctures, and tears. Do not blow into gloves to check for integrity, but if there is no external contamination, the glove may be squeezed to determine if the trapped air is escaping through small holes.

4.2.3.4 Removal

Take off gloves before leaving the laboratory. If using reusable gloves, wash them with soap and water before removing them, to remove possible contaminants. Get in the habit of removing gloves without touching the outside of the glove to clothing or skin. Wash hands with soap and water after removing gloves.

4.2.3.5 Replacement

Replace gloves often, depending on their frequency of use and permeability of the chemicals handled. Do not re-use disposable gloves.

4.2.3.6 Contaminated Gloves

Dispose of contaminated gloves by carefully removing them and placing them in a plastic bag. If they are grossly contaminated with hazardous chemicals, then manage them as hazardous waste.

4.2.3.7 Latex Gloves

Do not wear thin latex gloves in the lab. They provide very little protection from chemicals.

Latex gloves can be the source of allergic reactions, which can range from powder abrasion dermatitis to a life threatening hypersensitivity to the latex protein.

4.2.4 Respirators

Respirators should not be needed in a normal laboratory setting. Respirators may be required in certain situations involving the release of hazardous materials into the air that cannot readily be controlled by way of ventilation.

- Before performing any work requiring a respirator, you must first ascertain that the type of respirator you are using is the correct one and that you have been properly fitted to make sure it works efficiently. Persons using respirators need also to be trained in the proper use and maintenance of respirators.
- Simple disposable dust respirators may be used without specialized training, provided the dusts in the atmosphere are not considered to be at toxic levels. These are recommended in highly dusty areas, such as demolition sites or while performing dust generating activities like high speed cutting, sanding, or grinding.

4.2.4.1 Air Purifying Respirators

Air purifying respirators are respirators with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

Air purifying respirators shall not be used for protection in areas where H₂S is present in the atmosphere.

4.2.4.2 Air Supplied Respirators

Air Supplied Respirators are respirators that supply the user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

SCBA or SAR shall be provided where:

- Airborne contaminants exceed levels safe for filter masks
- There is an atmosphere deficient of oxygen
- the atmosphere is immediately dangerous to life or health

4.2.5 Hearing Protectors

Hearing protectors (earplugs or earmuffs) may be needed for some procedures or in some laboratory settings. If you suspect the noise levels may be potentially harmful, contact your safety officer for an evaluation. (A rule of thumb is that if you are in a noise environment for most of the day where you have to raise your voice to be intelligible to someone standing next to you, the noise levels may be potentially hazardous.)

4.2.6 Hard Hats

Hard hats are required:

- In all construction sites.
- When performing maintenance work involving overhead hazards, for example, under scaffolding or extension ladders, tree-pruning activities, etc.
- Any other designated areas i.e., where hard hat signs are posted.

4.2.7 Foot protection

- Approved steel-toed boots or shoes are required for all trades and are to be worn for all normal work situations.
- Good traction soles are recommended for icy, greasy, or wet situations.

4.3 Lone Working

Lone working increases the risks of work for several reasons, principally by increasing the consequences of accidents when things go wrong.

Lone workers at the University are staff (or postgraduate students) or contractors who work by themselves without close or direct supervision or assistance being close at hand. This does not mean only inexperienced persons but deliberately includes experts working in campus buildings or remote sites engaged in research or maintenance activities. In short this includes any person who does not have other people available to assist them in the case of an incident. Therefore, Lone workers should be capable of responding correctly to emergencies. Risk assessment should identify foreseeable events. Emergency procedures should be established and the people concerned trained in using the procedures.

Emergency Procedures may include,

- Process fires (fires resulting from the process or work being undertaken).
- Man-down procedures (if the person has an accident what needs to be done to recover them, especially important in high hazard laboratories).
- Actions to be taken in case of a chemical spill (especially high hazard substances)

4.4 Housekeeping

- Good housekeeping is an essential part of every job. Work areas, aisles, walkways, and equipment shall be kept clear of loose materials, tools, refuse, and scrap material.
- Materials such as lumber and pipe shall be stored in an orderly and secure manner away from high pedestrian traffic areas.
- Compressed gases, chemical products, or other hazardous materials shall not be left unattended in public areas. Gas cylinders, whether full or empty, should always be secured to a wall, bench, or rack.
- Spills such as grease, water, or oil shall be cleaned up as soon as possible; a delay could result in an accident to you or a fellow worker.
- A safe access shall be maintained to work areas. Shortcuts, such as through construction areas should be avoided. Never block aisles, traffic lanes, or fire exits with equipment or materials, and make sure members of the public are kept out of hazardous work areas, by way of barricades and signage.
- Restore work areas to their normal condition prior to leaving by replacing ceiling tiles and access panels which may have been removed during the course of your work.

4.5 Hand and Power Tools

- Before using any tool, first find out how to properly use it according to the operating instructions. If you need more information seek the advice of your supervisor/safety officer.
- Tools are to be used for no other purpose than their intended uses i.e., use the right tool for the job.
- Modification of tools or removal of safety devices is not permitted.
- Examine the condition of your tools before using them and before returning them to their place of storage. Never use defective tools, and make sure nobody else uses them. Report faulty tools either to your supervisor/safety officer or to the appropriate department for repair.
- Make sure you assume a comfortable position and use a firm grip when applying force to a tool, in order to avoid injuring yourself.
- Keep cutting tools sharp.

4.6 Equipment and Machinery

- Only properly trained individuals should operate power equipment or machinery.
- All electrical equipment and machinery shall be properly grounded. Control switches shall be located at the point of operations best suited to control the equipment.
- You should never adjust, repair, clean, or oil machinery or equipment while any of its parts are in motion. Use lock out switches to prevent accidental start-ups and make sure that someone else cannot energize the equipment while the repair work is in progress. Lock-out procedures should be approved by the supervisor/safety officer prior to commencement of the repair work. To be sure the equipment is effectively locked out, do a test to be sure the equipment cannot be activated. All guards must be replaced after completing repairs.
- All moving pulleys, shafts, gears or other machine components presenting shear, nip, or pinch points should be adequately guarded to prevent accidental contact with parts of the body.
- Loose clothing, jewelry, or long hair should be restrained before working on moving machinery.
- Always make sure proper maintenance activities held on all machinery and equipment to prevent premature failure or possible accident. Have all safety guards in place while testing repaired equipment.
- You should regularly inspect for cracks, stretching, etc. on cables, chains, clamps, hooks, and other equipment that are frequently placed under stress. Spreading, crimps, or cracks

- are warning signs of danger. If you feel the equipment is damaged or creating a possible hazard, report this to your supervisor/safety officer or to concern department immediately.
- Shop machines, including drill presses and bench grinders, should be securely anchored to the floor or bench.
 - The tool rest on a bench or pedestal grinder should be no further than 3 mm. away from the grinding stone.
 - Compressed air should not be used for cleaning clothing or any equipment.
 - Machines and machinery should be inspected on a regular basis to ensure they are in good working order and that all guards and safety devices are in place. Supervisor/safety officers are required to verify that inspections are done and corrective actions are taken on a timely basis.

4.6.1 Emergency Eyewashes and Showers

Emergency washing equipment is required when using corrosives (acids and caustics), strong irritants (which cause inflammatory effects upon contact), and toxic materials that can be absorbed through the skin. Emergency washing facilities must be accessible (unobstructed) and personnel should be able to reach the equipment within 10 seconds (not more than 50 feet and perhaps closer if access is through a normally closed door). Equipment must be accessible at all times without requiring a key or overcoming other security safeguards.

Each emergency eyewash must be activated weekly to check that it works and provides a strong enough stream of water to reach the eyes of someone bending over it, and to help keep the water clean. During the weekly check, the eyewash should be operated long enough so that there is no visible rust or contaminant in the water, perhaps 30 seconds. If the eyewash is located in a shared area, an individual should be appointed to perform the weekly test. Record this weekly test where it can be audited such as in your lab notebook or lab equipment maintenance log book.

Emergency showers are tested annually by Technical Affairs Department to ensure they continue to meet ANSI standard water flow requirements. A tag indicating the most recent test date should be found on the equipment.

4.6.2 Fire Safety Equipment

4.6.2.1 Flammable Liquid Storage Cabinets

Flammable liquid storage cabinets are required if you are storing over ten gallons of flammable liquids. Flammable liquid storage cabinets are not fireproof. Cabinets are designed to only protect the contents from extreme temperatures for a limited time.

4.6.2.1.1 Approval

Flammable liquids should be stored in an approved flammable liquid storage cabinet outfitted with approved automatic or self-closing doors.

4.6.2.1.2 Label

Cabinets must be labeled "Flammable - Keep Fire Away".

4.6.2.1.3 Capacity

Do not over fill cabinets. Check manufacturer's recommendations for storage limits.

4.6.2.1.4 Bottles

All bottles should be placed on the shelves, never stacked. Keep all containers tightly closed.

4.6.2.1.5 Incompatible Chemicals

Do not store incompatible chemicals in these cabinets.

4.6.2.1.6 Cabinet Doors

Cabinet doors should never be propped open unless the mechanism is a designed part of an approved cabinet.

4.6.2.1.7 Secondary Containment

There should be a secondary containment on each shelf and at the bottom of the unit. These plastic or rubber trays retain spills.

4.6.2.1.8 Unapproved Storage

Tops of cabinets are not storage shelves. Do not store combustible materials on or beside these cabinets.

4.6.2.1.9 Flammable Storage Refrigerators

Flammable chemicals or chemical mixtures that need to be stored below room temperature must be stored in designated Flammable Material Storage Refrigerators or Freezers. These refrigerators and freezers are specifically designed by the manufacturer to have non-sparking interiors. All laboratory refrigerators and freezers must be prominently labeled with a warning sign indicating whether it can be used for flammable or non-flammable storage.

4.6.3 Laboratory Signs

Laboratory signs may be either permanently mounted or mounted temporarily. A synopsis of mandatory and desirable signs is provided in the following table and explanatory material is described in the following paragraphs.

Table 4-2 Safety-Related Signs

Description of Sign	Status
Emergency contacts / phone numbers	Mandatory
Laboratory floor plan	Mandatory
Emergency / safety equipment location signs	Mandatory
Food and drink prohibitions	Mandatory if present
Area and equipment warnings	Mandatory if present
"NFPA 704"	See Section 4.C.6
"Sewer Discharge Log" for waste disposal sink	Mandatory if present
"Natural gas emergency shut off valve"	Mandatory if present
"Laboratory water – do not drink"	Mandatory if present
Lab-specific procedural / operational signs	Optional / Desirable

4.6.3.1 Emergency Numbers

Post a list of telephone numbers to be called in case of fire, accident, hazardous chemical spill or other emergency. The list should be posted prominently in each laboratory next to a telephone.

4.6.3.2 Laboratory Floor Plan

A plan showing evacuation route(s), as well as emergency and safety equipment locations should be posted prominently in each laboratory

4.6.3.3 Emergency/Safety Equipment Location Signs

Signs must be posted identifying the location of exits, safety showers, eyewash stations, fire extinguishers, first aid equipment, flammable storage cabinets, and other safety equipment.

4.6.3.4 Food and Drink Prohibitions

Label areas, refrigerators, freezers and other locations where food and beverages are not to be consumed or stored.

4.6.3.5 Area and Equipment Warnings

Operation and warning signs and labels must be posted on such things as alarm systems, biosafety cabinets, and fume hoods (sash opening height). Warnings may also need to be posted in areas or on equipment where special or unusual hazards exist, such as biohazards,

lasers, magnetic fields, radioactive materials, high voltage, restricted access, or particularly hazardous substance control areas.

Hazard areas are frequently indicated by familiar symbols. All workers in the laboratory must be familiar with these indicators and aware of the presence of the hazards.

4.6.3.6 National Fire Protection Agency (NFPA) Signs

Rooms where hazardous materials are stored or used in quantities that exceed certain thresholds ("H" occupancy as defined in the International Fire Code), and rooms dedicated to storing hazardous materials, must be posted with a National Fire Protection Association (NFPA) diamond sign (NFPA Standard 704) on all doors.

4.6.3.7 Lab-Specific Signs

For common procedures which may cause problems if important steps are neglected, laboratory staff may benefit from having a sign posted at the equipment used for the procedure that reminds staff of the steps that need to be followed.

4.6.4 Laboratory Ventilation

Local exhaust ventilation systems (such as fume hoods) may be needed in order to control airborne contaminants and reduce exposure levels to these acceptable limits. For assistance in measuring chemical exposures, contact your safety officer.

4.6.4.1 Laboratory Design

4.6.4.1.1 Room Air Pressure

Room air pressure should be negative to the hallway so that accidental releases are kept in the lab and not released into the hallway and the building.

4.6.4.1.2 Vents

Do not block or cover supply and exhaust vents.

4.6.4.2 Fume Hoods

A fume hood is ventilation equipment that vents separately from the building's heating, ventilation and air conditioning (HVAC) system. The primary means of controlling airborne chemical exposure is a fume hood. Fume hoods should be used when working with toxic compounds or compounds with a boiling point below 120°C. (However, some aqueous solutions may be an exception to this rule.) It may be necessary to use a closed system such as a glove box or bag for highly hazardous chemical materials.

4.6.4.2.1 Fume Hood Use

- 1) Training** – Personnel using fume hoods should be trained by Technical Affairs Department's Engineer.
- 2) Verify Operation** – Make sure the fume hood is operating before starting work.
- 3) Minimize Cross Drafts and Eddy Currents** – Air flow into the fume hood is adversely affected by cross drafts and eddy currents. Cross-drafts occur when people walk in front of a fume hood or when nearby windows or doors are open. Eddy currents occur around the person using the fume hood and around objects inside it. To limit these effects, fume hoods should not contain unnecessary objects and the slots within the fume hood which direct air flow must not be blocked. The slot at the rear of the work surface is essential for proper air movement. If large pieces of equipment or large numbers of bottles are placed in front of the slot, they should be raised up on blocks or placed on a shelf to allow air to flow into the slot. Equipment should be placed as far to the back of the fume hood as practical. Work should be performed at least six inches inside the fume hood opening to prevent cross drafts and eddy currents from pulling contaminated air out of the fume hood and into the room.
- 4) Sliding Sashes** – The sash should be kept as low as possible to improve overall performance of the hood. The more closed the sash is, the better protection from an unexpected chemical reaction.

- 5) Chemical Evaporation –It is illegal to evaporate chemicals in the hood to “dispose” of them. Any open apparatus used in hoods which emit large volumes of volatile chemicals should be fitted with condensers, traps, or scrubbers to contain and collect hazardous vapors or dusts.
- 6) Storage – Do not store chemicals or supplies in the fume hood. Chemicals and supplies should be stored in approved cabinets.
- 7) Flammable Liquid Vapor – Laboratory fume hoods are designed to reduce flammable vapors below lower explosive limits when properly operated and maintained. As an added precaution, use only non-sparking and explosion proof electrical equipment (hot plates, stirring plates, and centrifuges) in fume hoods where a large volume of flammable liquid vapor may be generated. Take care with flammable liquids and heat sources.
- 8) Containers – All containers of chemicals must be securely capped when not in use. A rule of thumb is that containers should be open for minutes at the most – which is the maximum time it normally takes to pour a small amount of chemical into another container and cap them. All containers must be labeled with the chemical identity and appropriate hazard warnings (or the material must be used up during the work period and it is under continuous control of the researcher using it).

4.6.4.2.2 Fume Hood Prep for Maintenance

- 1) Prior to any maintenance of fume hoods the entire interior surfaces must be decontaminated and/or cleaned. Decontamination of Equipment for Service, should be done by the researchers using the hood.
- 2) Maintenance may require access to the storage cabinets below the hood or to the sides of the hood. If this access is required, the entire cabinet and adjacent area also needs to be emptied, decontaminated, cleaned, and rinsed. Lab staff need to identify a contact for coordinating with Technical Affairs Department as to the work to be done.

4.6.4.2.3 Fume Hood Testing

- 1) Technical Affairs Department performs a functional performance test annually to assure hoods are performing as designed. If a hood fails, it may need to be taken out of service until repaired. Technical Affairs Department will notify the researchers and post a “do not use” sign if repair is required.
- 2) If you are having problems with your fume hood, contact Technical Affairs Department at 24141082.

4.6.4.3 Perchloric Fume Hoods

Procedures using concentrated perchloric acid (>70%) or which heat any amount or concentration of perchloric acid must be performed in a closed system or within a specially designed perchloric acid fume hood with wash down systems to prevent the accumulation of explosive perchlorates in the hood and ducting.

4.6.4.4 Biological Safety Cabinets

Biological Safety Cabinets (BSCs) are laboratory hoods designed to protect the worker and laboratory from the biohazards (infectious agents) of the experiment by drawing air across the samples and away from the worker and into a HEPA filter.

There are two types of BSCs. The Class II type A and Class II type B1 units recirculate filtered air into the laboratory and are not designed for chemical use for this reason. The Class II type B2 unit is designed for use of some chemicals but is not a substitute for a fume hood. The use of chemicals in this type of hood needs to be carefully evaluated so that the protective barrier (HEPA filters) is not destroyed by the chemicals.

Biological Safety Cabinets are certified annually should be Certified annually by Technical Affairs Department. If a BSC fails the certification, it may not be used until repaired.

BSCs may not be repaired or moved until decontaminated by concern researcher.

4.6.4.5 Cold Rooms, Warm Rooms and Environmental Chambers

4.6.4.5.1 Room Design

Controlled environment rooms generally are completely enclosed with no fresh air and heating/cooling and other environmental systems independent from the building. Rooms large enough to enter should be designed or retrofitted with doors that allow anyone trapped inside to get out easily. The electrical system within environmental rooms should be independent of the main power supply so that people are never left in these areas without light.

4.6.4.5.2 Chemical Use

Controlled environment rooms usually re-circulate the air using a closed air-circulation system. Hazardous chemicals must not be stored in these rooms because ambient concentrations of volatile chemicals can accumulate to dangerous levels.

Flammable solvents should not be used in controlled environment rooms. Ignition sources in these rooms could ignite vapors.

Avoid using volatile acids in cold rooms because vapors can corrode the cooling coils, leading to possible refrigerant leaks.

If solid carbon dioxide (dry ice) is placed into a cold room, its sublimation will raise the carbon dioxide levels within the room, possibly to dangerous levels. Use extra precautions if you must use or store dry ice in these spaces.

4.6.4.6 Other Ventilation Systems

Technical Affairs Department must design all other local exhaust systems used in the laboratory. You should not attach canopy hoods or snorkel systems to existing fume hood exhaust ducts without consulting Technical Affairs Department's Engineer.

4.6.4.6.1 Discharge of Hazardous Vapors

Laboratory apparatus that may discharge hazardous vapors (vacuum pumps, gas chromatographs, liquid chromatographs, and distillation columns) must be vented to an auxiliary local exhaust system such as a canopy or a snorkel, if not already vented to a fume hood.

4.6.4.6.2 Hazardous Chemicals

Hazardous chemicals should be stored in approved cabinets.

4.6.4.6.3 Isolation/Clean Rooms

Isolation rooms typically operate under negative pressure and clean rooms typically operate under positive pressure to the anterooms or hallways. These rooms require considerable engineering. Procedures for entering and exiting these areas should be written out and employees should be trained accordingly.

4.6.5 Other Facility Conditions

4.6.5.1 General Laboratory Environment

4.6.5.1.1 Floors and Walkways

- 1) Flooring - Floors should be level, with no protuberances which could cause a tripping hazard. Openings in the floor should be covered if possible or else protected or guarded to prevent falls. Carpets, mats, and rugs (if present) must be secure. Material spills should be cleaned up as soon as possible.
- 2) Obstructions - Equipment and supplies should not be placed where it would impede exit, either during normal operations (such as a file drawer which may open into an aisle) or in case of equipment failure (such as chemical reactions escaping a fume hood placed at the entrance to a room). Hoses and electrical cords should be strung along the ceiling instead of crossing aisles on the floor.

4.6.5.1.2 Plumbing Systems

Place a strainer or mesh pad over all sink drains to prevent objects falling into the plumbing.

Piping systems and plumbing connections in a room should be labeled. Such plumbing systems may include sewage lines, potable water lines, non-potable water systems, cryogenic and pressurized gases, or other systems. All personnel should know what to do in case of a leak in any system.

If experimental procedures will require connecting laboratory apparatus to any plumbing, personnel must also know how to avoid improper connections (i.e., avoiding mistakes such as connecting to the wrong system or making an inappropriate cross-connection).

4.6.5.1.3 Lighting

- 1) Light Fixtures – Light fixtures should be operational and diffusers should be installed.
- 2) Lighting Intensities – Light intensities should be adequate for the tasks being performed. If lighting seems inadequate when all fixtures are working, consider obtaining additional fixtures, especially if the laboratory arrangement is temporary. In a few cases, increased lighting may be required to reduce potential hazards from activities such as laser use or ultraviolet light applications

4.6.5.1.4 Noise and Vibration

When possible, equipment that produces irritating noise and vibration should be replaced with equipment designed to produce less noise and vibration. If equipment in the area is producing noise levels that require people to raise their voices to be heard while standing next to each other, potentially hazardous noise levels are being produced.

Equipment should not be purchased which produces noise levels greater than 80 dBA.

4.6.5.1.5 Indoor Air Quality

- 1) Occupant Activities – Many complaints about odors are due to occupant-generated problems. Such sources include dried-out drain traps in sinks and floor drains, chemical spills inside a laboratory or adjacent area, rotting food within a room, and expected or unexpected chemical reactions creating a stench. The room occupants should check these potential problems. If a dry trap is suspected, the trap should be filled with a few hundred milliliters of water at least once a month, or infrequently pour ten or twenty milliliters of a slower evaporating chemical such as glycerin, propylene glycol (not ethylene glycol) or mineral oil into the drain.
- 2) Facility-Related – Recurring poor indoor air quality may be due to inadequate or malfunctioning general HVAC systems. In some cases, odors may come from a leak in a plumbing system (such as natural gas or sewage), an open drain that was never capped by maintenance in charge when a piece of equipment was decommissioned, or a construction project in an adjacent area.

4.6.5.1.6 Other Hazardous Facility Components

Other Building Materials – Other structural materials that could present a health hazard include poly-chlorinated biphenyls (PCBs) in fluorescent light fixtures and transformers, liquid mercury switches in piped gas systems, mercury in fluorescent and high pressure light bulbs, flammable or toxic gases in piped gas systems, and potentially hazardous materials in sewage plumbing and ventilation ducts

4.6.5.1.7 Building Repairs and Alterations

Employees within Building are not authorized to repair or alter facilities. Facility problems such as broken flooring and broken electrical cover plates should be corrected by initiating a work request to Technical Affairs Department.

4.6.5.2 Electrical Hazards

Even small electrical currents passing through the body may cause injury or death. Observe the following precautions to reduce electrical risks.

4.6.5.2.1 *Circuit Breaker Access*

- 1) Access – Maintain at least three feet clearance in front of any circuit breaker panels within the laboratory.
- 2) Utility Access in Other Rooms – If you must enter other rooms to access the circuit breakers, you must be observant of any conditions in that room which may indicate a hazard.

4.6.5.2.2 *Permanent Wiring and Outlets*

Request permanent wiring be installed for situations when you would be using extension cords for periods longer than 8 hours. All building electrical repairs and wiring must be done by Technical Affairs Department. If conduits appear damaged or cover plates over electrical outlet boxes are damaged or missing, please report that information to the Technical Affairs Department.

4.6.5.2.3 *Equipment Cords and Extension Cords*

- 1) Extension cords should be a minimum of 14 gauge size (heavy-duty) and be in good condition with no splices, knots, deterioration, taping, damage, or sharp, permanent bends. Plugs (220/240 volt) must have three prongs with a grounding prong longer than the current-prongs.
- 2) Extension cords may never be used in place of permanent wiring.
- 3) Carpeting, heavy objects, and equipment that may abrade or melt an electrical cord should never be placed on top of electrical cords. Cords should serve only one fixture or piece of equipment. Cords should never be strung through holes in walls or ceilings, or over metal fixtures such as pipes or equipment racks, because cord movement may abrade the cord.

4.6.5.2.4 *Chemical Splashes into Electrical Equipment*

Place equipment so as to reduce the chances of a spill of water or chemical on the equipment. If a spill occurs while the equipment is unplugged, the spill should be promptly cleaned, and the equipment must be inspected before power is applied.

4.6.5.2.5 *Grounding*

Equipment must be properly grounded (using three-prong plugs for 220/240-volt power), especially in “wet” areas. Electrical outlets in “wet” areas must have ground fault circuit interrupters (GFCIs). (However, these devices only interrupt flow of electricity to ground and may not stop flow of electricity when completing an electric circuit with two “live” wires.)

4.6.5.2.6 *Equipment Modifications*

Any problems with electrically powered equipment should be brought to the attention of the laboratory supervisor/safety officer or Technical Affairs Department. If equipment set-up is modified, someone knowledgeable with the apparatus should check the new set up, before power is applied. Equipment operators must understand the hazards of equipment and apparatus in use, and be familiar with the correct operation of that equipment. Power line cords should be unplugged before any modifications or repairs are made to equipment. Even though power may need to be applied to equipment while calibrations are performed, the operator must remain wary of the energized state of the equipment and not adjust the equipment beyond safe operational parameters.

4.6.5.3 *Lock-Out/Tag-Out Concerns*

4.6.5.3.1 *Hazardous Situations*

In addition to common electrical hazards, other energy hazards may exist in the laboratory that require special procedures, called Lock-Out/Tag-Out procedures. These situations may include equipment with internal pressurized systems (hydraulic or gas), multiple electrical energy source systems (where electricity is supplied through more than one cord), systems containing batteries or capacitors, and gravity systems (where a weight is held at a height). Such systems

must be labeled with a warning sign. Anyone using such systems must know of the hazard and that only trained and authorized individuals may repair and modify the equipment.

4.6.5.3.2 Precautions

Trained and authorized personnel must perform all repairs and modifications. When repairs and modifications are performed, the energy source must be prevented from being activated, using appropriate techniques such as de-energizing the system, inserting blanks into pressure systems, and locking out controls with individualized locks.

4.6.5.4 Equipment Guards and Mounting

4.6.5.4.1 Guards

Belts, pulleys, and other exposed moving equipment parts must be guarded. Equipment covers should be in place.

4.6.5.4.2 Instruction Manuals

Operator's manuals should be available and workers using the equipment should know where such manuals can be found, and should review the manuals prior to using the equipment.

4.6.5.4.3 Mounting

Equipment designed to be used in a particular location should be permanently fixed in place to prevent movement from vibration. This is especially important for equipment which may topple (e.g., a drill press) or which needs to be balanced (e.g., a centrifuge).

4.6.5.5 Confined Spaces

SQU site contain equipment and facilities (such as large tanks or incinerators chambers...etc) that maintenance team Technical Affairs Department's Engineers may need to enter. If potentially hazardous exposures may occur in a confined space, the space will need to be controlled as a permit-required confined space. Special training and other precautions are required for permit-required confined space entry. Coordinate with your safety officer to get the require permit.

4.6.6 Pressure Vessels and Systems

Pressure vessels and systems with operating pressures greater than 15 pounds per square inch, gauge (psig) are of potential concern. Design should produce a protection factor of 4:1 up to 10:1 depending upon design parameters and whether the system can be safely tested. A pressure relief device to safely release pressures greater than 10% above the operating pressure should be installed.

4.6.7 Decontamination of Work Areas

Laboratory personnel are responsible for providing a clean and unobstructed work area for all maintenance and service personnel. Floors should be cleaned regularly and kept free of obstructions.

4.6.8 Decontamination of Equipment for Disposal

Laboratory equipment is often contaminated with hazardous materials and/or may be inherently unsafe.

To surplus contaminated or potentially contaminated laboratory equipment, you must first make sure that the equipment is safe for handling.

Examples of equipment that must be decontaminated fume hoods, ovens, refrigerators, freezers, sinks, storage cabinets, lockers, bins, and tanks.

Any equipment capable of generating dangerous radiation or containing radioactive sources must be checked by the Safety Office.

5 FIRE SAFETY

5.1 Introduction

Sultan Qaboos University endeavors to protect faculty, staff, students and facilities by constructing operating and maintaining buildings and by adopting procedures which minimize the risk of injury or damage from fire.

Staff, faculty, students, visitors, contractors and other users of the University buildings shall observe standard fire safety practices and shall not tamper with equipment or systems which are designed to detect fire or limit the spread of fire or smoke through a building.

Guided by the Directorate General of Civil Defense and in co-operation with the University HSE Department, Sultan Qaboos University installs and maintains fire equipment as appropriate in each University building. Included among this equipment are smoke and heat detectors, sprinklers, stand pipes, fire hoses and extinguishers, emergency lights and alarm systems and signage.

In the University Colleges, Centers and Units, the HSE Committee through the Dean or the Director shall appoint a building fire warden. With the assistance of the HSE Committee, the building fire warden will be assigned responsibility for the following.

- Developing and maintaining a building emergency evacuation plan.
- Conducting, at least annually, a fire drill in which all occupants evacuate the building under a simulated emergency condition.
- Supervising the evacuation during emergencies.

5.2 Discovering a Fire

Anyone discovering a fire must:

- Raise the alarm by Breaking a red fire alarm call point OR "*Shout Fire*"
- Call the Fire Defense by:
 - Telephoning **4444** on a University internal telephone
 - OR Telephoning the number shown on the fire action notice Report:
 - i. The exact location of the fire
 - ii. Whether there are any casualties
 - iii. Whether there are any special hazards
- Only if it is safe to do so should the fire be tackled with an appropriate portable extinguisher. Human safety must come first. If the fire is to be left, all doors should be closed to prevent its spread.
- Evacuate the building and proceed to the nearest assembly point.

5.3 Users of a Building

All users of a building should:

- Commit the emergency procedures to memory.
- Ascertain the whereabouts of the telephone nearest to their work area for summoning assistance.
- Locate the nearest fire extinguisher appropriate to the type of activity being undertaken.
- Know the location of the various escape routes - the lifts must not be used after the fire alarm has been activated.

5.4 Staff and Students

Staff and students are expected to observe the following requirements:

- Once per annum a full fire evacuation drill is held in every major building of the University. Such exercises are intended to familiarize the occupants with the sound of the alarms and the procedure to be followed.
- All staff, postgraduates and people working out of hours must undertake fire training once per annum. After an initial attendance at a Fire Training Lecture subsequent training can be done using the web based training package
- Some University premises rely upon different alarm arrangements, and occupants must ensure that they understand the local fire notices.
- Unimpeded and adequate access to premises for fire appliances and ambulances must be maintained at all times. External exits to buildings must not be blocked by careless parking of vehicles.
- Wherever possible arrangements need to be made in advance to ensure that assistance will be provided for disabled staff and students in the event that the building needs to be evacuated. HSSE Committee can provide guidance on the type of assistance that may be necessary.

6 ELECTRICAL SAFETY

6.1 Introduction

The University is committed to ensuring people's health and safety while at work, an important component of which is electrical safety. The University shall ensure:

- that all business is undertaken in a way that is electrically safe;
- that all electrical equipment used is electrically safe;
- the electrical safety of all people and property likely to be affected when performing electrical work.

6.2 Scope

This electrical safety policy applies to all staff, students, visitors and contractors and to all Sultan Qaboos University workplaces.

6.3 Application

6.3.1 General Obligations

Sultan Qaboos University buildings and electrical infrastructure are under the control of the Department of Technical Affairs and this department will be responsible for the appropriate testing of those systems and for making records available as required.

The Vice Chancellor, Deputy Vice Chancellors, Deans, Heads of Departments, and Directors of Centers are responsible for general and electrical safety in their own areas and the workplaces of their general and academic staff. This includes following up on testing and tagging of relevant plant/equipment and provision and testing of portable safety switches where required.

Specific situations and responsibilities include:

- Meeting room equipment that belongs to Colleges or Centers is their responsibility.
- Any electrical equipment that is owned by the College and used for teaching or research work, including use in teaching and research laboratories, clinics and workshops is the College's responsibility.
- Equipment owned by Center of Information System or Center of Educational Technology in teaching and research laboratories is the responsibility of these centers in terms of testing and tagging.
- If staff bring domestic/other appliances into the workplace, the relevant manager must ensure it is tested and tagged before use at the workplace.
- If students bring electrical equipment for use in research/projects/artworks etc. the relevant academic supervisor must ensure it is tested and tagged before use.
- For off campus activities, the relevant organizing element is responsible for testing and tagging of electrical equipment and provision and testing of portable safety switches, as required.
- External parties renting University space are responsible for testing and tagging of non-University electrical equipment brought onto and used within the leased work area, and provision of safety switches as required.
- New specified electrical equipment should be tagged with the purchase date/date of first use to identify its due date for testing and tagging.
- All staff are responsible for reporting of electrical hazards or damaged electrical equipment to the Projects and Maintenance Department Hotline Ext **3333** on all campuses.

6.3.2 Electrical Equipment and Installations

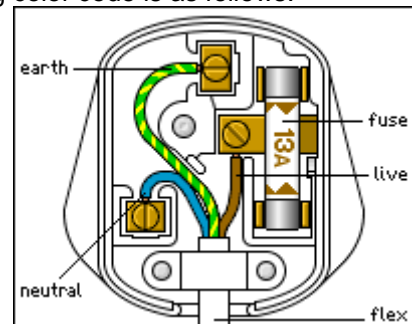
6.3.2.1 General Safety Requirements

- The work area must be set up so electrical cords, cables and equipment are protected from damage (including damage by liquids).
- Staff and students must be educated to inspect for and immediately report any physical damage to electrical cords and appliances.
- The use of safety switches may be required in certain situations. Safety switches and portable safety switches must be tested at prescribed intervals by a competent person and removed from use if not working properly.
- All defective equipment must be removed from service immediately, be labeled accordingly, and be reported at once to the person responsible for initiating appropriate repairs.
- Double adaptors and piggyback plugs are not to be used. The only exception is theatrical equipment such as lighting and audio. Where it is necessary to connect more than one piece of equipment to a single mains outlet, a properly manufactured distribution board (not a multiway adapter) incorporating a 13 amp fuse must be used.
- Only trained competent persons must carry out repairs and adjustments to electrical equipment and machinery.
- All wiring, whether permanent or temporary, must be neat, orderly, safe and sited so that it will not cause a tripping hazard or itself suffer unnecessary mechanical damage or wear.
- All plugs must be sound and correctly wired. The wiring color code is as follows:
 - ✓ Earth - Green and Yellow striped
 - ✓ Live Mains - Brown
 - ✓ Neutral – Blue

Note however, that in some older equipment and in equipment from other countries, a different color code may be used and expert advice must be obtained before wiring such items.

It is also essential to have a fuse of the correct rating in the plug. The correct ratings are usually as follows:

- ✓ 2 amp for loads up to 400 watt
- ✓ 5 amp for loads up to 1200 watt
- ✓ 13 amp for loads up to 3 kilowatt



- External metal casings of electrical apparatus, cables and conduits must be earthed. "All insulated" and "double insulated" equipment requires no earth connection and will be marked as such. To ensure that the insulation remains effective all such equipment should be tested by a suitably trained member of staff on a time scale which reflects their use.
- All specialist electrical equipment must be wired, serviced and tested by experienced staff who must ensure that terminals and conductors are protected to avoid electric shock. Equipment must be sited to avoid contact with water or contamination by other liquids and must not form an ignition source for flammable materials. Where there is a danger that electrical apparatus may come into contact with water, the supply should be protected with RECB circuitry.
- When flammable solvents are in use, a suitably qualified person will need to assess the risk of a flammable atmosphere being formed. It may be necessary to use flameproof equipment (including motors, sockets, lights etc.): expert advice should always be sought. Equipment must be fitted with high temperature safety cut-outs as appropriate. High voltage capacitors must be short-circuited when not in use.
- All high voltage equipment (i.e. high voltage, HV, 650V to 3000V; and extra high voltage, EHV, above 3000V) MUST be adequately enclosed, with screens placed at an acceptable distance from any live parts. Warning notices saying "DANGER - HIGH VOLTAGE" must be attached in a conspicuous position and a standard up-to-date notice concerning electric shock treatment must be displayed prominently in the vicinity. No person may enter a high voltage enclosure until all the supplies are isolated and relevant apparatus earthed. Access will be restricted to suitably qualified competent persons only.
- 3-phase outlets must NOT be used for single-phase equipment.

6.3.2.2 Safety switches (or Residual Current Devices)

Although certain parts of the University are protected by safety switches (or Residual Current Devices), the University requires testing and tagging of specified electrical equipment in all cases. In some cases portable safety switches may also be required. This is due to the difficulty of identifying exactly which parts of buildings are protected, and of preventing or tracking the movement of specified electrical equipment from a protected to a non-protected area.



6.3.2.3 Teaching Laboratories

- Laboratories used for teaching which expose students to electrical apparatus and circuitries should have their own electrical safety Code of Practices which should explain the specific safety procedures for conducting experiments and handling the electrical equipment in the laboratory.
- The laboratory instructors and their technical supporting staff must organize safety induction lectures to students at the beginning of every semester.
- Safety instructions should be reminded to students at the beginning of every laboratory session.
- Safety instructions, posters, and emergency contact numbers must be displayed and made well visible to people in the laboratory.
- All equipment in teaching laboratories should conform to electric safety standards and should be tested regularly for their electric safety.

6.3.2.4 Medical equipment

A higher standard of testing applies for medical equipment. This includes the following tests:

- Protective Earth Test
- Insulation Resistance Test
- Earth Leakage Current Test
- Applied Part Leakage Current Test
- Mains Contact Current Test

6.3.2.5 Theatrical Equipment

Equipment exceeding 20 amps as used in conference halls and lecture theatres must be tested and tagged by a licensed electrician every 6 months.

6.3.2.6 Personal Electrical Equipment

If personal electrical equipment is brought to a University workplace, it must be tested and tagged prior to it being brought onto University premises or being used for University purposes.

6.3.2.7 Lending/Hire of Equipment

University electrical equipment which is loaned/hired out (even if monies are not exchanged) must be inspected, tested and tagged by a competent person every 6 months. Whoever provides the equipment must perform and record a visual inspection of the equipment prior to and after loan/hire.

6.3.3 Working Around Live Electrical Parts

No live work is to be carried out in the University, with the exception of testing and fault-finding, where there is no reasonable alternative to performing the electrical work other than by live work. The University must ensure that work performed does not involve:

- A person coming into direct contact with a live electrical part;
- Any operating plant or vehicle coming into direct contact with an electrical part;
- A person coming within the exclusion zone for the electrical part; or
- Any operating plant or vehicle coming within the exclusion zone for the operating plant or vehicle for an electrical part.

6.3.4 Incident Notification and Reporting

Any minor shocks or “tingles” from electrical equipment or electrical infrastructure (wiring, switches or plugs) must be reported immediately to the Maintenance Department Hotline Ext **3333** on all campuses.

All serious electrical incidents and dangerous electrical events must be reported immediately to the supervisor and the element/group Workplace Health & Safety Officer, who will arrange notification to SQU Workplace Health and Safety Office within 24 hours of becoming aware of the incident or event. If a person has been killed in a serious electrical incident, the report must be made immediately by phone, fax or other suitable form of communication. If the event occurs after hours SQU Security must be notified to Hotline Ext 3351 / 5999

6.4 Delegated Authorities

- The Director of Technical Affairs Department is responsible for appropriate testing of building electrical infrastructure.
- Vice Chancellor, Deputy Vice Chancellors, Deans, Heads of Departments, and Directors of Centers are responsible for electrical safety, including following up on testing and tagging, of their equipment and facilities within their areas of responsibility.

7 CHEMICAL HAZARD

7.1 Introduction

Preventing exposure to chemicals in the laboratory can be achieved by using good laboratory technique, sound apparatus and paying careful attention to personal hygiene. The purpose of this Code of Practice is to indicate the steps that should be taken in order to prevent or control exposure.

The hazards associated with the chemicals and techniques used must be ascertained before an experiment is undertaken, the risks to health and safety assessed, recorded, and the appropriate precautions adopted.

Each individual in the laboratory is responsible for his or her own safety and for the safety of others affected by the work. This includes responsibility for:

- assessing, planning and carrying out the experiment
- safe storage of chemicals;
- emergency procedures;
- the ultimate disposal of all substances involved; and
- Special control measures for substances assessed as high risk, eg hydrofluoric acid.

Overall responsibility for laboratory safety rests with the research and/or laboratory supervisor, and ultimately with the Head of Department.

The basic principle is to treat all chemicals as potentially dangerous and to prevent contact (exposure) between chemical and worker. This involves:

- containing the chemical, eg using closed systems, replacing tops on bottles, using fume cupboards etc; and
- protecting the worker, eg wearing personal protection such as gloves, eye protection, laboratory coats etc.

7.2 Scope

This code objective is to protect staff, postgraduate and undergraduate students, who work in a chemical workplace at SQU, from hazards of chemicals, to prevent or reduce the incidence of chemically induced illnesses and injuries resulting from the use of chemicals at work and, consequently, to enhance the protection of the general public and the environment by providing guidelines for:

- 1) ensuring that all chemicals for use at work, including impurities, by-products and intermediates, and wastes that may be formed, are evaluated to determine their hazards;
- 2) ensuring that employers are provided with a mechanism for obtaining information, from their suppliers, about the chemicals used at work to enable them to implement effective programs to protect workers from chemical hazards;
- 3) providing workers with information about the chemicals at their workplaces and about appropriate preventive measures to enable them to participate effectively in safety programs;
- 4) establishing principles for such programs to ensure that chemicals are used safely;
- 5) making special provision to protect confidential information whose disclosure to a competitor would be liable to cause harm to an employer's business so long as the safety and health of workers are not compromised in this manner.

7.3 Application

This code applies to any work activity in which chemicals are used at Sultan Qaboos University.

The provisions of this code should be considered as basic requirements for preventing or reducing the risks to workers' health and safety when using hazardous chemicals.

This code provides assessment, controls, checks and records on safety in the use of chemicals, as well as emergency and reporting measures.

7.4 Risk Assessments

All chemicals and potentially hazardous substances should be treated as dangerous unless there is evidence to the contrary. A COSHH assessment must take into account the risks posed by the use of any substance which may be hazardous, detailing appropriate precautions for use, minimizing the risk, containment, any protective clothing requirements and the ultimate means of disposal of any product or residual material. In addition, the assessment must identify actions required for dealing with any foreseeable emergencies arising from the procedure. If health surveillance or monitoring is appropriate, these must be specified and appropriate arrangements made. In the case of known well documented substances, the relevant information may be found in reference books, data bases or obtained from the manufacturers. However it is important to realize that manufacturer's data by itself does not normally constitute a suitable and sufficient assessment as the assessment must also consider the conditions, volumes quantities and forms and reactions with other substances with which it may come into contact. In the case of new or less well-documented substances or reactions, the best available advice should be sought and procedures should be designed to cope with unexpected hazards.

7.5 Purchasing and Obtaining Chemicals

All chemicals will normally be obtained through a single departmental channel. If any other source whatever is used (such as a gift from another establishment), the Departmental Safety Officer or the person normal responsible for the safe processing of chemical orders must be informed, preferably in advance. Materials should not be introduced into a central storage area (e.g. from a laboratory) without the permission of the person in charge of supervising stock intake.

7.6 Hazardous Chemicals: Definition and Identification

"Hazardous chemical" defines a chemical for which there is significant evidence that acute or chronic health effects may occur in exposed employees. Hazardous chemicals are generally identified as health hazards and physical hazards materials. Health hazards chemicals include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. Physical hazards include chemicals for which there is scientifically valid evidence that they are combustible liquids, a compressed gas, explosive, flammable, organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water reactive.

7.6.1 Toxic Hazard Criteria

A substance will be considered as a toxic hazard substance requiring the use of procedures for toxic chemicals when the Material Safety Data Sheets (MSDS) or container label identifies or describes the substance as toxic.

7.6.2 Fire Hazard Criteria

A substance will be considered to present a fire hazard requiring the use of procedures for fire hazards when any one of the following criteria is met:

- 1) The MSDS or container label identifies or describes the substance as *flammable* or *combustible*.
- 2) "*Combustible liquid*" is any liquid having a flashpoint at or above 37 °C but below 93 °C.
- 3) "*Flammable chemicals*":
 - "Gas, flammable" indicates a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% by volume or less.
 - "Liquid, flammable" means any liquid having a flashpoint below 37 °C.
 - "Solid, flammable" implies a solid that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard.

Flash point (FP): the lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture with air. Examples:

Compound	Flash Point (°C)
diethyl ether	- 45.0
acetone	- 17.8
isopropyl alcohol	11.7

7.6.3 Reactivity Hazard Criteria

A substance will be considered to present a reactivity hazard requiring the use of procedures for reactive chemicals when any one of the following criteria is met:

- 1) The MSDS or container label identifies or describes the substance as unstable, reactive, explosive, dangerous when wet, pyrophoric, oxidizer, or organic peroxide.
- 2) The substance fits the definition of unstable (reactive), explosive, organic peroxide, oxidizer, or water reactive
 - **Unstable (reactive)** means a chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, pressure, or temperature.
 - **Explosive** means a chemical that causes sudden, almost instantaneous release of pressure, gas, or heat when subjected to sudden shock, pressure, or high temperature.
 - **Organic peroxide** denotes an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by organic radicals.
 - **Oxidizer** means a chemical that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.
 - **Water-reactive** means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.
- 3) A pyrophoric substance indicates a chemical that will ignite spontaneously in air at a temperature of 54 °C or below.

Examples: oxidizers: bleach, bromine, nitrite, chlorate.

Peroxides forming substances: Di-isopropyl ether, sodium amide, dioxane, tetrahydrofuran, butadiene, acrylonitrile, divinyl acetylene, potassium amide, diethyl ether,
Pyrophoric: white phosphorous, iron sulfide

7.6.4 Corrosivity Hazard Criteria

A substance will be considered to present a corrosivity hazard requiring the use of procedures for corrosive chemicals when any one of the following criteria is met:

- 1) The MSDS or container label identifies or describes the substance as corrosive
- 2) The substance causes visible destruction of, or irreversible modification in living tissue by chemical action at the site of contact. Examples of corrosives include:
 - liquid corrosives such as inorganic acids: hydrochloric, nitric, sulphuric acids and acetic acid.
 - Solid corrosives: NaOH and KOH.
 - Gaseous Corrosives: Bromine and Chlorine gases.
 - Others such as hydrofluoric acid, perchloric acid and ammonia.

7.6.5 Contact Hazard Criteria

A substance will be considered to present a contact hazard requiring the use of procedures for contact hazards when any one of the following criteria is met:

- 1) The MSDS or container label identifies or describes the substance as irritant, or sensitizer.

- 2) The substance is recognized as “irritant” or “sensitizer”:
 - Irritant implies a chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact.
 - Sensitizer implies a chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

7.6.6 Particularly Hazardous Substance Criteria

MSDS or container label identifies or describes particularly hazardous substance requiring the use of procedures for particularly hazardous substances as carcinogen, reproductive toxin, or highly toxic.

7.6.7 Compressed Gas Hazard Criteria

A substance will be considered to present a compressed gas hazard requiring the use of procedures for compressed gases when any of the following criteria is met:

- 1) The MSDS or container label identifies or describes the substance as a compressed gas.
- 2) The substance meets the definition of a “compressed gas”.

A compressed gas means:

- a gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 21 °C.
- a gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 54.5 °C regardless of the pressure at 21 °C.

7.7 Employee Information and Training

7.7.1 Chemical Safety Training

All employees potentially exposed to hazardous chemicals while performing their laboratory duties must have access to information and training to ensure that they are apprised of the hazards of chemicals present in the work area. The content of the training programs will include the following:

- Physical and health hazards of various classes of laboratory chemicals
- Methods/procedures for handling and safely using chemicals present in laboratories;
- Appropriate response in the event of a chemical emergency (spill, overexposure, etc.)

7.7.2 Chemical Safety Information Sources

There are numerous sources of chemical safety information. These sources include:

- 1) the labels found on containers of hazardous chemicals
- 2) the substance's Material Safety Data Sheet
- 3) special health and safety reference literature available in several libraries across the campus and on the web;
- 4) signs and charts posted in your all laboratories dealing with hazardous materials

7.7.2.1 Container Labels

All containers of hazardous chemicals must be labeled with the name of the chemical(s) and the hazard(s), if not provided by the manufacturer. If a chemical has more than one hazard, it must be labeled with both hazards. For example, acetaldehyde is both a flammable and a carcinogen, and must be labeled appropriately. Additionally, the following guidelines must be applied:

- 1) All peroxide forming chemicals must be labeled with the date upon receipt and upon opening. After the recommended disposal date, usually 3 or 12 months, the chemical shall be tested for peroxides or disposed of properly.
- 2) Date all explosive or shock-sensitive materials upon receipt and upon opening.

- 3) Stationary process containers such as tanks may be identified with signs, placards, process sheets, batch tickets or other written materials instead of actually affixing labels to process containers.
- 4) Portable containers into which hazardous chemicals are transferred from labeled containers and which are intended to be under the use and control of the person who transferred it, within the work shift in which it was transferred, are exempt from labels. However, it is recommended that a temporary label identifying the chemical and its primary hazard be affixed to the container.
- 5) All sample containers or prepared solutions must be labeled. If there is a large quantity of containers with the same chemical, labeling of the container, tray, cupboard or refrigerator will be enough.

NFPA Diamond labels

The National Fire Protection Association (NFPA)

Health (blue)

4 deadly
3 extreme danger
2 hazardous
1 slightly hazardous
0 no unusual hazard

Specific hazard

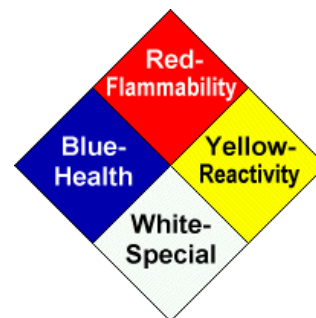
ACID = acid
ALK = Alkali
COR = Corrosive
W= use no water

Fire Flammability (RED)

Flash points
4 below 73 F
3 below 100 F
2 above 100 F
1 above 200 F
0 will not burn

Reactivity (yellow)

4 may detonate
3 shock and heat may detonate
2 violent chemical change
1 unstable, if heated
0 non-reactive



7.7.2.2 Waste Containers

All hazardous chemical waste should be segregated and labeled. Special attention should be given to the following areas:

- 1) Waste containers for non-contaminated glass must be labeled (label as "Broken Glass") and kept separate from other non-contaminated waste.
- 2) Upon initial waste collection, attach a "Hazardous Waste" label containing the accumulation start date.
- 3) Once a container has been dated and labeled as a hazardous waste, it may not be accumulated for more than 180 days.

7.7.2.3 Material Safety Data Sheets

A Material Safety Data Sheet (MSDS) is a detailed informational document prepared by the manufacturer or importer of a hazardous chemical which describes the physical and chemical properties of the product. Information included in a Material Safety Data Sheet aids in the selection of safe products, helps employers and employees understand the potential health and physical hazards of the chemical, and describes how to respond effectively to exposure situations. It should be noted that the health and safety guidance in the Material Safety Data Sheet is often very generic and addresses worst case situations. Material Safety Data Sheets for most chemicals are readily available on-line.

MSDS and other information sources can be found at the following web sites:

- <http://www.ilpi.com/msds/>
- <http://hazard.com/msds/>
- <http://msds.ehs.cornell.edu/msdssearch.asp>
- <http://www.atsdr.cdc.gov/mhmi/>
- <http://www.christie.ab.ca/safelist/>

-<http://www.sra.org/riskanal.htm>
-<http://listuvm.edu/archives/safety.html>
-<http://mfc.engr.arizona.edu/safety/MSDS%20FOLDER/>
-<http://www.osha.gov/dts/sltc/methods/inorganic/id215/id215.html>

If you do not have web access and want to review a hard copy form of an MSDS, you can contact the chemical manufacturer and receive MSDSs directly from the supplier.

The format of a Material Safety Data Sheet may vary but there is specific information that must be included in each sheet. All MSDSs contain in general the following information:

- Identity of the product, using the name used on the original label
- The chemical and common names of the hazardous ingredients, if in concentration >1% (>0.1% for carcinogens)
- Physical and chemical characteristics of the product
- Physical and health hazards of the product, specifying carcinogens at >0.1% concentration
- Exposure limits, if any
- Safe handling and use information
- Engineering and personal protective equipment control recommendations
- Emergency and first aid procedures
- Date of the MSDS revision
- Name and contact information of the chemical manufacturer, importer, or other responsible party preparing or distributing the MSDS.

7.7.2.4 Signs

Important signs of the following types should be posted in each laboratory:

- Door ID cards outside each laboratory listing the names and telephone numbers of the Principal Investigator and other responsible laboratory personnel. These cards must be kept updated and are used by emergency responders in the event of an off-hours emergency in the laboratory.
- Signs identifying locations for safety showers, eyewash stations, other safety and first aid equipment, and exits.
- Emergency contact numbers prominently located on or near the laboratory phone.
- Radiation safety or biological safety signs at laboratory doors, sinks, benches, hoods, etc, as appropriate.
- Warnings at areas or equipment where special or unusual hazards exist.

7.8 Standard operating procedures working with hazard chemicals

7.8.1 General safety principles

- 1) Look at the hazards associated with the materials being used by carefully reading the label and reviewing the Material Safety Data Sheet (MSDS) provided by the supplier.
- 2) Know the location and proper use of emergency equipment (e.g. - fire alarms, fire extinguishers, emergency eyewash, and shower stations) and know the appropriate emergency response procedures.
- 3) Use appropriate safeguards for each chemical in use, including personal protective equipment.
- 4) Know the proper storage for chemicals when not in use.
- 5) Use proper methods of transporting chemicals within the facility.

- 6) Always be alert to unsafe conditions and actions and call attention to them so that corrective action can be taken.
- 7) Avoid distracting or startling other workers when they are handling hazardous chemicals.
- 8) Always inspect equipment for leaks, tears and other damage before handling a hazardous chemical. This includes fume hoods, gloves, goggles, etc.
- 9) Use proper personal hygiene practices.

7.8.2 Health and Hygiene

Common practices to protect laboratory employees from health risks associated with the inhalation, ingestion, injection, or absorption of hazardous chemicals:

- 1) Avoid direct contact with any hazardous chemical. Know the types of protective equipment available and use the proper type for each job.
- 2) Do not ever use pipette by mouth.
- 3) Do not eat, drink, smoke, chew gum, or apply cosmetics in the laboratory.
- 4) Wear leather gloves when inserting glass tubing into cork or rubber stoppers.
- 5) Pick up broken glass using tongs.
- 6) Wear appropriate eye protection at all times.
- 7) Confine long hair and loose clothing and always wear footwear that fully covers the feet.
- 8) Wash thoroughly with soap and water after handling chemicals, before leaving the laboratory and before eating or drinking.
- 9) Wash immediately if skin or eye contact is made with any chemical, regardless of corrosivity.
- 10) Do not sit on lab benches.
- 11) Remove all personal protective equipment, including gloves and goggles, before leaving the laboratory.
- 12) Change clothing as soon as possible after leaving the laboratory and launder work clothes often.

7.8.3 Food and Drink in the Laboratory

It is strictly prohibited to eat, drink, smoke or apply cosmetics in laboratories where radioactive, biological, or chemical hazards are present. There shall be no storage, use or disposal of these 'consumable' items in laboratories (including refrigerators within laboratories)

7.8.4 Housekeeping

Housekeeping practices contribute significantly towards chemical hygiene and safety. To maintain an orderly laboratory, the following guidelines should be used regularly:

- 1) Keep work areas clean and uncluttered with chemicals and equipment.
- 2) Clean up work areas upon completion of an operation and at the end of each workday, including floors.
- 3) Do not block exits or access to emergency equipment including safety showers, eyewashes, and fire extinguishers.
- 4) Clean spills immediately and thoroughly. Ensure a chemical spill kit is available and that employees know how to use it.
- 5) Keep wastes in their proper containers and label them appropriately.
- 6) Ensure hazardous chemicals are properly segregated into compatible categories and placed in an appropriate storage area.
- 7) Ensure all chemical containers are labeled with both the name of the chemical(s) and the hazards they present.

- 8) Treat any unlabeled containers at the end of the workday as waste.

7.8.5 Chemical Handling and Storage

It is essential to handle and use hazardous chemicals properly from initial receipt to disposal.

- 1) Proper handling, storage and disposal of hazardous chemicals and access to related Material Safety Data Sheets should be made available to all laboratory employees prior to the use of the chemical.
- 2) Always purchase the minimum amount necessary to maintain operations. Conduct periodic inventories and discard unneeded items or return them to the stockroom.
- 3) Chemical containers with missing or unclear labels or that violate appropriate packaging regulations should not be accepted.
- 4) Chemicals used in the laboratory must be appropriate for the laboratory's ventilation system.
- 5) Chemicals should not be stored on high shelves.
- 6) Chemicals shall be segregated by compatibility.
- 7) Chemical storage areas must be labeled as to their contents
- 8) Storage of chemicals at the lab bench or other work areas shall be kept to a minimum.
- 9) Avoid exposure of chemicals to heat or direct sunlight.
- 10) Any chemical mixture shall be assumed to be as toxic as its most toxic component.
- 11) Substances of unknown toxicity shall be assumed to be toxic.

Examples of incompatible chemicals

Certain chemicals when mixed together may create hazardous conditions) e.g. toxic gases, explosions)

Incompatible chemicals should not be stored together.

General classes of incompatible chemicals:

A	are not compatible with	B
Alkali and alkaline earth (e.g Na)		water
Carbides		acids
Hydrides		halogenated organic compounds
Hydroxides		halogenating agents
Metals, oxides and peroxides		oxidizing agents
Azides (inorganic)		acids, heavy metals and their salts, oxidizing agents
Cyanides, inorganic		acids, strong bases
Nitrites, inorganics		acids, reducing agents
Organic compounds		oxidizing agents
Organic acyl halides		bases, organic hydroxyl and amino compounds
Organic anhydrides		bases, organic hydroxyl and amino compounds

7.8.6 Transporting Chemicals

Take care when carrying chemicals, glassware etc between laboratories, paying special regard to swinging doors, staircases and other people who may be passing. Winchesters must be transported in suitable carriers – a bottle must never be moved by the neck only.

Special consideration should be given to the transport of chemicals in lifts. If there is any possibility of leakage or accidental damage putting anyone at risk who is in the same lift, the substance should travel in a dedicated goods lift or where a passenger lift is the only option it should travel unaccompanied with suitable warning notices displayed to advise others of the hazard.

If chemicals are transported by private car, it is important to ensure that appropriate insurance cover is in place. Ensure that the materials are packed safely and incompatible chemicals are not transported together.

7.8.7 Unattended Operations

At times, it may be necessary to leave a laboratory operation unattended. Follow these basic guidelines in the design of an experiment to be left unattended:

- 1) Develop a protocol for potential interruptions in electric, water, inert gas and other services and provide containment for toxic substances as part of the protocol.
- 2) A warning notice must be posted in the vicinity of the experiment if hazardous conditions are present (e.g. – on the laboratory door).
- 3) Leave lights on in the laboratory.
- 4) Never leave an operation unattended if it involves the use of particular hazardous substances.

7.8.8 Working Alone

- 1) Avoid working alone whenever possible.
- 2) If you must work alone outside of normal working hours, the laboratory supervisor must be notified.
- 3) Never work alone with particularly hazardous substances or substances of unknown toxicity.

7.8.9 Prior Approval

Any new procedure should be subjected to review to ensure that all safety considerations are in place prior to implementation. Approval from the laboratory supervisor to proceed must be obtained if any of the following criteria are met:

- 1) The procedure or task is a new one.
- 2) There is a change, substitution, or deletion in the procedure or task.
- 3) There is a substantial change in the amount of chemicals used.
- 4) There is a failure of any of the equipment used in the process or task (e.g. fume hoods.)
- 5) There are unexpected test results, in which case a review of how the new result impacts safety practices must be made.
- 6) Laboratory staff suspect exposure, detect a chemical's odor, or otherwise suspect a failure of any safeguards.
- 7) Members of the laboratory staff will be working alone or a procedure or a task will be unattended.
- 8) A particularly hazardous substance is used.

7.8.10 Storage and Disposal of Hazardous Waste

Chemical waste includes a wide range of materials including discarded chemical products and process wastes. The following briefly describes the storage and disposal process for chemical waste:

- 1) Individual laboratories are responsible for the safe collection and storage of hazardous waste at their site. The container should be marked with an accumulation start date, the words "Hazardous Waste", and with the contents of the container identified.
- 2) Hazardous wastes must be segregated into waste streams. Never put sulfide or cyanide containing wastes into a container that might contain acids.
- 3) Waste stored at the point of origin should be kept to a minimum. Containers should be closed and dated when they become full or within 180 days and moved to the hazardous waste holding area within 3 days. Waste will be removed from the holding area at least

every 180 days. This can be done during the mid-semester break and after the summer research session.

- 4) No quantity of hazardous chemicals may be transported over public highways without proper packaging, classification, labeling, and documentation. Consequently, hazardous waste will be transported from the College for treatment or disposal only by licensed hazardous waste Transport, Storage, and Disposal facilities.

7.8.11 Standard repair and transfer / close-out / transportation procedures

7.8.11.1 Repair and Transfer Procedures

When a request for equipment repair or transfer to another location is initiated, the following steps must be undertaken to ensure the safety of the employees responsible for repair or transfer if the equipment has been contaminated by hazardous chemicals:

- 1) Remove chemical contaminants with an appropriate solvent or cleaning solution.
- 2) Once contaminants have been eliminated, fill out an "Equipment Release Form" and place in a prominent position on the equipment to be repaired or transferred.

7.8.11.2 Close-Out Procedures

Whenever a laboratory worker engaged in scientific investigation leaves the College or is transferred to a different location, proper disposition of hazardous materials is required. This includes faculty, staff, and students.

The following procedures should be completed before the responsible individual leaves the College or transfers to a different location on campus:

- 1) Assure that all containers of chemicals are labeled with the name of the chemical and all known hazards. All containers must be securely closed.
- 2) Clean chemicals from glassware, assuring proper waste disposal guidelines are followed.
- 3) Remove regulators from gas cylinders, replace cap, and return cylinders to the supplier. If cylinders are non-returnable, follow disposal procedures.
- 4) Check refrigerators, freezers, cold rooms, fume hoods, glove boxes, storage cabinets, and bench tops for chemical containers and dispose of items used by the departing researcher. This includes facilities that are shared with other researchers.
- 5) If chemicals are still usable, transfer the responsibility of the chemical to another laboratory worker who is willing to take charge of the chemical.
- 6) Label all hazardous waste and notify the chemical hygiene officer for pick up at least one week prior to vacating the lab.
- 7) Notify the Department when the laboratory or containment area/rooms have been cleared.

7.8.11.3 Transportation Procedures

A licensed transporter should be contacted to package and deliver materials to a new location on campus. Transportation of chemicals off campus is regulated by local laws. Contact the Departmental safety officer when chemicals must be transported off campus.

7.8.11.4 Packaging and Shipping Procedures

Packaging and shipping of chemicals is regulated by local laws. Contact Departmental safety officer when chemicals must be shipped off campus, regardless of quantity or recipient.

7.9 Hazard specific standard operating procedures

7.9.1 Hazard identification

Identifying the specific hazard associated with a chemical greatly reduces chances of misuse by regular laboratory employees, new users, or visitors to the laboratory. At the very minimum, hazardous chemical containers must have the chemical name(s) and hazard identification(s). With respect to identifying containers, storage areas and laboratory entrance ways, the following conditions entail hazard identification:

- 1)** Laboratory supervisors must ensure that labels on incoming containers of hazardous chemicals for laboratory use are not removed or defaced. Labels contain information on the identity of the chemical(s) in the container and the hazard identification of the chemical(s).
- 2)** Laboratory supervisors must ensure that laboratory containers (those containers filled from the original shipping container) of chemicals are labeled.
- 3)** Laboratory supervisors must ensure that employees have access to MSDSs.

7.9.2 Chemicals Developed in the Laboratory

The following requirements apply to chemical substances developed in the laboratory:

- 1)** If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the laboratory supervisor must determine if it is a hazardous chemical. This can be done by a literature search for similar substances. If the chemical is determined to be hazardous, the laboratory supervisor must provide appropriate training to protect employees.
- 2)** If the chemical produced is a product or a by-product whose composition is not known, the laboratory supervisor must assume that the substance is hazardous and must comply with the requirements in handling hazardous materials.
- 3)** If the chemical is produced commercially for another user outside of the laboratory, the laboratory supervisor must prepare an appropriate MSDS.

7.10 Laboratory emergency situation

7.10.1 Emergency Situation-Spill

If the spill meets the definition of an emergency as described above, execute the following:

- Pull the fire alarm
- Contact the departmental safety officer or superintendent of your department
- Isolate the spill area and close doors to the room where the spill occurred.
- Remove ignition sources and shut down equipment.
- Establish exhaust ventilation to the outside of the building only
- Evacuate.

7.10.2 Emergency Situation-Body Splash

- Remove person(s) from spill area to fresh air only if attempts to rescue victim(s) do not present a danger to the rescuers.
- Remove contaminated clothing while under an emergency shower.
- Flood affected area with cold water for at least 15 minutes or longer if pain persists.
- Wash skin with mild soap and water - do not use neutralizing chemicals, creams or lotions.
- Contact emergency response personnel and assure they know the chemical(s) involved.

7.10.3 Emergency Situation-Eye Splash

- Remove victim(s) from spill area to fresh air only if attempts to rescue victim(s) does not present a danger to the rescuers.
- Lead the victim(s) immediately to an emergency eye wash facility.
- Hold eye lids open.
- Flush eyes for at least 15 minutes or longer if pain persists.
- Contact emergency response personnel and assure they know the chemical(s) involved.

7.10.4 Mercury Spills

For very small spills, less than 1 cc, such as a broken thermometer:

- use mercury absorb sponges or powder, to pick up mercury droplets
- Cover small droplets in inaccessible areas such as cracks with Hg vapor absorbent. Test and repeat if a Hg vapor level remains.
- Place residue in container for hazardous waste collection.
- Contact safety officer or superintendent in your department.

For large spills, i.e. greater than 1 cc, contact the safety officer or superintendent for spill cleanup, instructions or assistance.

7.10.5 Spill Kits

Ready access to a chemical spill kit is required in laboratories that work with hazardous chemicals. Minimally, such a kit should contain:

- splash resistant goggles
- chemical resistant gloves
- plastic bags
- multi-chemical absorbent (enough for 2 gallon spill)
- scoop

Most spills greater than 1 liter in volume require assistance from trained personnel.

Some absorbents are chemically specific. The best absorbents are those which can be used to clean up all types of chemical spills. Check absorbents in spill kits for their absorbency range. Spill kits should be kept in a readily accessible location and each employee should be trained on how to use the spill kit.

7.10.6 Non-Emergency Situation – Spill

If the spill does not meet the definition of an emergency as described above, and you have been trained in spill response, cleanup, and disposal and feel comfortable doing it, execute the following:

- 1) Locate the appropriate spill kit.
- 2) Choose the proper protective equipment:

Always wear gloves and protective eye wear

Use additional protective equipment such as an apron, coveralls, or boots as needed.

- Confine or contain the spill.
- Dispose of spilled materials and disposable personal protective equipment.
- Restock spill kit and personal protective equipment.

For non-hazardous spills:

- Cover liquid spills with spill kit absorbent and scoop into a plastic disposal bag.
- Sweep solid materials into a dustpan and place in a sealed container.

- Dispose of waste as normal trash as long as substance is non-volatile, non-hazardous.

For hazardous spills:

- Cover liquid spills with spill kit absorbent and scoop into an appropriate disposal container (As a rule of thumb, the container should be of the same type that the chemical came from. For example, if the spill is from a chemical that was stored in glass bottle, the disposal container should be made of glass).

7.11 Disposal of hazardous Waste

The method of disposal of waste must be determined before the start of any procedure. In particular, waste solvents and hazardous materials must not be poured down the drain. Waste solvents must be segregated into approved categories, for disposal via the University's used solvent collection system. Safety Services can provide advice if required. Also see the 'Waste Management' procedures on the Energy and Environment Web site.

Acids, alkalis and other corrosive substances should be neutralized before disposal down sinks, sluices or drains. (see Chapter 11)

Hazardous waste should be collected in four main containers

Inorganic, halogenated organic, non-halogenated organic and oxidizing compounds.

- Always dump waste reagents in appropriate containers. Keep a list of the container contents taped to the container.
- All waste containers should be labeled as hazardous waste with the physical state, hazard properties, component percentage and product names
- All waste containers must have the lid screwed on when not being actively filled

7.12 First Aid and Personal Protective Equipment (PPE)

7.12.1 Flammable materials

7.12.1.1 First aid procedures for exposures to flammable materials:

Inhalation or ingestion Exposures - remove person from the contaminated area if it is safe to do so. Get medical attention and do not leave person unattended.

Dermal Exposures - remove person from source of contamination. Remove clothing, jewelry, and shoes from the affected areas. Flush the affected area with water for at least 15 min. and get medical attention.

Eye Contact - remove person from the source of contamination. Flush the eyes with water for at least 15 minutes. Obtain medical attention.

7.12.1.2 Personal Protective Equipment

Always use a fume hood while working with flammable liquids. Nitrile and neoprene gloves are effective against most flammables.

7.12.2 Reactive materials

7.12.2.1 First Aid

- If someone is seriously injured the most important step to take is to contact emergency responders as quickly as possible. Explain the situation and describe the location clearly and accurately.
- If a person's clothes are on fire, he or she should drop immediately to the floor and roll. If a fire blanket is available, put it over the individual. An emergency shower can also be used to douse flames.

- If a person goes into shock, have the individual lie down on their back if safe to do so and raise the feet about one foot above the floor.

7.12.2.2 Personal Protective Equipment

Wear appropriate personal protective clothing while working with highly reactive materials. This include impact resistant safety glasses, a face shield, gloves, a lab coat and a shield. Conduct work within a chemical fume hood as much as possible and pull down the sash as far as is practical.

7.12.3 Corrosive Materials

7.12.3.1 First Aid

Inhalation - remove person from source of contamination if safe to do so and get medical attention. Keep person warm and quiet and do not leave unattended.

Ingestion - remove person from source of contamination. Get medical attention and inform emergency responders of the name of the chemical swallowed.

Skin Contact - remove person from source of contamination and take immediately to an emergency shower or source of water. Remove clothing, shoes, socks, and jewelry from affected areas as quickly as possible, cutting them off if necessary. Be careful not to get any chemical on your skin or to inhale the vapors. Flush the affected area with water for a minimum of 15 minutes. Get medical attention.

Eye Contact - remove person from source of contamination and take immediately to an eyewash or source of water. Rinse the eyes for a minimum of 15 minutes. Have the person look up and down and from side to side. Get medical attention. Do not let the person rub their eyes or keep them tightly shut.

7.12.3.2 Personal Protective Equipment

Always wear the proper gloves when working with acids. Neoprene and nitrile gloves are effective against most acids and bases. Polyvinyl chloride (PVC) is also effective for most acids (see glove compatibility information). A rubber coated apron and goggles should also be worn. If splashing is likely to occur, wear a face shield over the goggles. Always use corrosives in a chemical fume hood.

7.12.4 Oxidizers

7.12.4.1 First Aid

In general, if a person has inhaled, ingested, or come into direct contact with these materials, the person must be removed from the source of contamination as quickly as possible when it is safe to do so. Medical help must be summoned. In the case of an exposure directly to the skin or eyes it is imperative that the exposed person be taken to an emergency shower or eyewash immediately. Flush the affected area for a minimum of 15 minutes, then get medical attention.

7.12.4.2 Personal Protective Equipment

In many cases, the glove of choice will be neoprene, polyvinyl chloride (PVC) or nitrile. Be sure to consult a glove compatibility chart to ensure the glove material is appropriate for the particular chemical. Always use these materials in a chemical fume hood as most pose a hazard via inhalation. Cylinders of compressed gases should be kept in ventilated cabinets.

7.12.5 Precautions in dealing with toxic chemicals:

- 1) Chemicals of low toxicity require continual caution. (Treat All chemicals as potentially toxic)
- 2) Never eat or drink, use tobacco, apply cosmetics, handle contact lenses, or take medication in the lab. Wear the appropriate protective gear (PPE) and always remove PEE in the way out of the lab.
- 3) Reproductive Toxins should be handled only in a fume hood, using appropriate protective apparel (especially suitable gloves) to prevent skin contact. Reproductive toxins should be properly labeled and stored in well ventilated areas in unbreakable secondary containers, if possible. Notify supervisor/instructor of all incidents of exposure or spills.

- 4) High Acute Toxicity Chemicals** (more rules to be followed in addition to those mentioned above):
- Use and store these chemicals in areas of restricted access and posted with special warning signs. These areas should include a fume hood for procedures that may generate aerosols or vapors containing the substance.
 - Use gloves, long sleeves and other protective apparel as needed to avoid skin contact. Always wash hands after working with these chemicals.
 - Maintain records of the amounts of these materials on hand, amounts used and the names of the workers involved (Risk assessment forms COSHH).
 - Assure that at least two people are present at all times if a compound in use is highly toxic or of unknown toxicity.
 - Be prepared for accidents and spills. If a major spill occurs outside the hood, evacuate the area and assure that cleanup personnel wear suitable protective apparel and equipment.
 - Store contaminated waste in closed, suitably labeled, secondary containers (for liquids, plastic bottles half-filled with vermiculite).

7.13 Incident Notification, Reporting and Response

Any injuries in the chemical laboratories must be dealt with at once for first aid with immediate reporting to the Technical Services Department – Safety Engineering Section Ext. **2701/ 2702** on all campuses with an immediate transportation to the emergency unit at SQUH (Appendix C).

8 PHYSICAL HAZARDS

8.1 Introduction

There are a number of common physical hazards in this category; compressed gas, cylinders, fume cupboard, heating equipment. Materials or equipment, which present a physical hazard can be safely used if the specific hazard(s) are understood. If appropriate precautions are not taken, personal injury or property damage may occur.

8.2 Compressed Air

A compressed air line should never be pointed at the body. There is a danger that air can enter the bloodstream through a cut or abrasion on the skin with possibly fatal results. This has been known to happen, for example, when someone was using compressed air equipment to clean overalls after work - a highly dangerous practice.

Blowing machinery with compressed air may blow out swarf which may enter the operator's eyes. Eye protection must be worn when doing this task, and care must be taken not to put anyone nearby at risk.

For any equipment which uses compressed air it must be remembered that there may be a hazard from stored energy unless the pressure inside and outside the equipment is equalized. Care must be taken when opening up equipment, to ensure first that pressures are equalized.

Compressors, or more particularly the air receiver, must have a Written Scheme of Examination (see Section 10.2, Pressure Vessels).

8.3 Pressure Vessels

The most important aspect of any pressure vessel or attached equipment is to know the safe working pressure and ensure that this is not exceeded. The safe working pressure should normally be displayed prominently on any equipment and the mode of operation of any valves clearly indicated. There should be a clear emergency shutdown procedure to be applied in the event that the safe working pressure is exceeded, and this should be prominently displayed by the pressure vessel. A list of authorized users should also be displayed. Users should be trained in safe operation and emergency procedures before they are authorized.

The Pressure Systems Regulations use the concept of stored energy, and this is estimated by multiplying the pressure in bars (i.e. above atmospheric) by the volume in liters. Any pressure system where this pressure volume multiplier is greater than 250 bar-liters requires a written scheme of periodic examination and subsequent adherence to that schedule.

8.4 Cylinders

Compressed gas cylinders, which contain a variety of gases or liquefied gases, are safe if treated correctly. If handled incorrectly or accidentally damaged the consequences can be extremely serious. Large quantities of toxic or flammable gas may be released, rendering a large area potentially lethal; a damaged valve can result in uncontrolled discharge of gas at 230 psi, turning a gas cylinder into a jet-propelled missile.

Nearly all gas cylinders in the University are rented from reputable suppliers and should thus be suitable to withstand the appropriate pressure. Out of use cylinders should be returned to the suppliers and not allowed to become rusty. Cylinders should conform to the standard color coding, for example:

black	oxygen or carbon dioxide
grey	air
grey with black top	nitrogen
bright red	hydrogen
maroon	acetylene
blue	butane or medical nitrous oxide
cream	nitrous oxide (industrial)
black with grey top	carbon dioxide

8.4.1 Storage and Movement of Cylinders

Cylinders should be stored in fire-resistant, well-ventilated areas located away from ignition sources, excessive heat, fresh air intakes and not subject to direct sun. Lighting should be of flame-proof design and switches should be outside the enclosure. Cylinders may, if necessary, be stored in the open, but precautions should be taken to prevent rusting. Full and empty cylinders should be kept apart and clearly labeled. Only the minimum number of cylinders possible should be located within workrooms. Flammable gases, especially hydrogen, should not be kept permanently within buildings. The gases should preferably be piped in from external storage, or where this is not feasible, kept in fire-resistant cupboards ventilated to the outside. Cylinders must be handled carefully, never dropped or allowed to collide. Cylinders may only be lifted by crane etc. if the supplier specifically permits a hook or wire loop around the valve assembly or the valve guard. Cylinders should be moved about using a proper cylinder trolley, with the cylinder chained or strapped into position. Cylinders containing permanent gases (e.g. oxygen, nitrogen, air, carbon dioxide) may be stored or used in any position, but any cylinder containing a liquefied gas (propane, butane) must be stored and used in an upright position. Any cylinders in an upright position must be safely located in a cylinder store, chained to a wall or bench, or secured in a cylinder trolley.

8.4.2 Acetylene

Unlike other permanent gases or liquefiable gases, acetylene becomes unstable when compressed. The cylinders **MUST** be used and stored upright. Stringent requirements under the Explosives Regulations govern the use of acetylene; it cannot be supplied at more than 0.6 bar (9 psi) without permission, between 0.6 and 1.5 bar (9-21 psi) it is possible to obtain exemptions, but above 1.5 bar it is not recommended to supply acetylene without specialized equipment. Acetylene must never be permitted to come into contact with copper or silver piping or fittings as dangerously explosive metal acetylides may be formed.

8.4.3 Cylinder Valves and Heads

Cylinder valves, unless of the knob or handle type, should only be opened and closed with the correct key. Undue force should not be used. Any cylinders with a valve that needs to be hammered shut should be marked and returned to the suppliers as soon as possible. This is particularly relevant with oxygen, as a leaking valve can cause a build-up of an oxygen-rich atmosphere, which although not in itself flammable, can assist a spark to become a serious fire, which in normal air would not occur. The neck of the cylinder head should be free of water, dust or grease before a regulator is attached. The practice of 'sniffing' cylinders to clear this, or to check on contents, is discouraged as foreign bodies could be ejected with great force, and a valve which sticks open presents a serious hazard, except perhaps in the open air.

8.4.4 Compressed Gas Regulators

Regulators for use with toxic or flammable gases, or other gases where a release would be hazardous (e.g. oxygen), should be replaced or service exchanged every five years. The diaphragm deteriorates with age and may become prone to failure, releasing the contents of the cylinder into the environment. Regulators should be marked with a "DO NOT USE AFTER " label, where the date given is five years after the date of purchase. If this is not known, then the suppliers can advise how to work out the date of purchase from a code marked on the regulator.

For regulators with very toxic or dangerous gases (e.g. arsine, fluorine, silane), or where the gas requires an unusual regulator, the supplier's advice should be followed.

Regulators which are only for "inert" gases such as argon, air, carbon dioxide, helium and nitrogen do not really form a serious hazard if a regulator were to fail and allow contents to leak. Such a failure is extremely unlikely to occur other than when someone is actually adjusting the cylinder valve or regulator control, and thus remedial action could be taken. Regulators for these gases can remain in service until they cease to function properly, provided they are suitable for the increased cylinder pressures currently applied.

It is important that regulators labeled or used on inert gases are not subsequently transferred to an oxygen cylinder. Grease or organic impurities may be introduced, which can cause an explosive reaction with oxygen.

8.5 Heating Equipment

8.5.1 Ovens

It has been known for serious fire to result from a failed thermostat on an unattended oven. Consequently, ovens which are left unsupervised must have secondary over temperature protection.

If ovens are used for materials which will release flammable vapors or fumes, they must be spark proof. If they may produce toxic vapors or fumes they must be vented directly to the outside, unless the quantities involved are very small and specific COSHH assessment shows that venting to the laboratory is acceptable (*see appendix*).

Older ovens may have asbestos insulation. If it is accessible it must be treated with a sealant or removed. Suspected unsealed asbestos must be reported to the Safety Officer, Buildings and Estates.

Suitable heat protective gloves must be worn when working with ovens or furnaces.

Some ovens or furnaces have exposed live electrical heating elements. There must be adequate interlocking to ensure that power to the element is cut off when the door is opened.

8.5.2 Furnaces

All furnaces using gas as fuel must have clear ignition/start-up instructions prominently displayed in a convenient position near the furnace. Manufacturers' instructions must be followed. Where electrical or gas furnaces are kept at constant temperature a notice indicating the temperature must be displayed.

8.5.3 Heating Mantles

The safety record for the use of electric heating mantles to distil highly flammable liquids is good, although there is always a risk of ignition in the case of breakage or spillage. However, an unacceptable risk exists if the temperature of the heating element exceeds the auto-ignition temperature for the vapor. This can be a risk particularly if different solvents are distilled in the same area. For example, diethyl ether vapor will ignite at 180°C and it would not be acceptable to distil ether and toluene near each other, because of the high mantle temperature in the toluene distillation.

8.5.4 Microwave Ovens

Microwave ovens are increasingly being used for heating. Care must be taken to avoid over-pressurization of containers. When heating agar or other media, the top of the container must be very loose or, ideally have a cotton wool plug.

Care must be exercised if liquids (e.g. media or a cup of tea) are heated in a microwave oven. The liquid may become superheated and suddenly erupt when the container is disturbed. This has caused serious scalds to the hands or even face.

8.5.5 Hotplates

Soda-glass bottles are not suitable for heating on hot plates. Only thermally resistant glass (e.g. pyrex) should be exposed to direct heat in this way. Care should be taken when dealing with hotplates to ensure that there is no risk of igniting combustible materials.

8.6 Vacuum Systems

Improperly designed or used systems, both of glassware or metal, where the pressure inside the apparatus is lower than the atmosphere pose a danger of flying debris and contents from around.

Glassware vacuum systems are particularly at risk and eye protection must be worn. As far as possible, vacuum apparatus should be screened. Flasks and so on may need to be enclosed in wire mesh cages; covering with PVC tape may help, but can never be totally effective. It is important to ensure that rubber bungs are of sufficient size to prevent their being sucked into apparatus. Stopcocks should be properly lubricated and opened slowly.

8.7 Fume Cupboards and Safety Cabinets

8.7.1 Purpose of Fume Cupboards

Fume cupboards are designed to protect personnel from fumes, vapors or aerosols generated by procedures incorporating hazardous or noxious substances. They generally discharge the materials, greatly diluted, to atmosphere but recirculating filtered fume cupboards may be used for certain limited applications. These should not be installed without discussions with Safety Services.

8.7.2 Checking the Efficiency of Fume Cupboards

All fume cupboards should be fitted with a simple air-flow indicator which should be checked before any procedure commences and at least daily for long term procedures. Any deficiency must be reported at once to the Laboratory Superintendent or Departmental Safety Officer, who will take steps to ensure that the unit is taken out of service or limited in use as appropriate, and will arrange with Property Services for repairs to be carried out. All fume cupboards and local exhaust ventilation systems must have a thorough engineering and performance check every 14 months.

8.7.3 Use of Fume Cupboards

Fume cupboards should be cleared of potentially dangerous materials before an experiment is started, and two experiments using incompatible chemicals must NEVER be performed simultaneously in the same fume cupboard. Whenever possible, the fume cupboard sash should be kept in the lowered position. If access to apparatus is required, then it should be lifted only as far as is necessary to perform the required manipulations. Minimizing the opening not only optimizes the airflow but affords a safety screen in the event of an eruption or explosion. Fume cupboards must not be used for the storage of equipment or chemicals which can sensibly be stored elsewhere – e.g. acid bins, solvent storage cupboards and chemical stores.

8.8 Physical Hazard specific standard operating procedures

8.8.1 Provisions for Fire Hazards

For a fire to occur, three conditions must exist simultaneously: presence of flammable gas in the proper concentration, presence of an oxygen rich environment (usually the air), and a source of ignition. Removal of any one of the three conditions will prevent a fire. The following standards shall be observed when handling materials that produce a fire hazard.

- 1) Eliminate ignition sources such as open flames, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity.
- 2) Store in approved flammable liquid containers or storage cabinets, in an area isolated from ignition sources or in a special storage room designed for flammable materials.
- 3) Ensure there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drum. Assure bonding and grounding is checked periodically.
- 4) All procedures involving flammable materials in excess of 100 milliliters shall be carried out in an operational fume hood.
- 5) Assure appropriate safety equipment (e.g. – fire extinguishers, spill kits) is in the area where the procedure will be carried out.

8.8.2 Provisions for Reactive Hazards

The hazard associated with materials classified as reactive is the variable and potentially high rate at which energy may be released under normal conditions, or when struck, vibrated, or otherwise agitated. The following standards shall be observed when handling materials that produce a reactive hazard.

- 1) Know the reactivity of the materials involved in the experiment or process. Ensure there are no extraneous materials in the area which could become involved in a reaction.

- 2) Quantities should be limited in the initial experiments to assess the level of energy released and potential control problems. Special reviews should be established to examine operational and safety problems involved before an experiment is scaled up.
- 3) If the reaction is anticipated to be violent or explosive, use shields or other methods for isolating the materials or the process. Barriers should completely encircle the reaction vessel.
- 4) Tongs should be used for handling containers of the hazardous material at a safe distance. Remote-controls, such as stopcock turners, lab jack turners and remote cable controllers, should be available to avoid exposure of any part of the body to injury.
- 5) Gloves, such as “electrical” linesman’s gloves, shall be worn when it is unavoidably necessary to reach behind a shielded area while an experiment is in progress.
- 6) Laboratory coats should be worn at all times to reduce minor injuries from flying glass or an explosive flash.
- 7) A face shield, providing throat protection, shall be worn at all times when a worker is in an exposed position, such as when shields are moved aside, when handling or transporting materials, or when manipulating equipment.
- 8) Pyrophoric chemicals should be used and stored in inert environments.
- 9) Some chemicals become increasingly shock-sensitive with age. Contact the chemical hygiene officer when it is suspected that the inadvertent formation of shock-sensitive materials in chemicals being stored has occurred.
- 10) Do not open any peroxidizable container which has obvious solid formation around the lid.
- 11) Addition of an appropriate inhibitor to quench the formation of peroxides is recommended.
- 12) Store light-sensitive materials in a cool, dark place in amber colored bottles or other containers which reduce or eliminate penetration of light.

8.8.3 Provisions for Compressed Gas and Cryogen Hazards

Special systems are needed for handling materials under pressure. Cylinders pose physical and/or health hazards, depending on the compressed gas in the cylinder. The following standards shall be observed when handling materials that produce a compressed gas hazard.

- 1) Cylinders with regulators must be individually secured. Only cylinders with valve protection caps securely in place may be safely gang-chained.
- 2) When storing or moving a cylinder, have the valve protection cap securely in place to protect the stem.
- 3) Cylinders must be secured in an upright position at all times. Use suitable racks, straps, chains, or stands to support cylinders against an immovable object, such as a bench or a wall, during use and storage. Do not allow cylinders to fall or lean against one another.
- 4) Use an appropriate cart to move cylinders.
- 5) Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.
- 6) Oil or grease on the high-pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder. Use an oxygen approved regulator.
- 7) Always wear goggles or safety glasses with side shields when handling compressed gases.
- 8) Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.

- 9)** Oil or grease on the high-pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder. Use an oxygen approved regulator.
- 10)** Always wear goggles or safety glasses with side shields when handling compressed gases.
- 11)** Always use appropriate gauges, fittings, and materials compatible with the particular gas being handled.
- 12)** When working with a toxic, corrosive, or reactive gas is planned; the MSDS should be reviewed for information concerning specific handling requirements. Generally, these gases will need to be used and stored with local exhaust ventilation such as a lab hood or a gas cabinet designed for that purpose.

Liquefied gases that condense oxygen from the air create an oxygen rich atmosphere and increase potential for fire if flammable or combustible materials and a source of ignition are present. Pressure is also a hazard due to the large expansion ratio from liquid to gas, causing pressure build up in containers. Many materials become brittle at extremely low temperatures. Brief contact with materials at extremely low temperatures can cause burns similar to thermal burns. Some of the hazards associated with cryogenics are fire, pressure, weakening of materials, and skin or eye burns upon contact should be placed in plastic cryogenic storage ampoules. Reheat cold materials slowly.

9 BIOLOGICAL HAZARDS: BIOSAFETY

9.1 Introduction

Personnel who work in biological laboratories may handle infectious agents in addition to other hazardous substances such as chemicals and radioactive materials. Over the years, there have been many documented cases of lab personnel acquiring diseases from their work with infectious agents.

Whenever working with infectious agents, all appropriate steps must be taken to protect personnel and the environment.

9.2 Routes of Exposure and Laboratory Practices

There are basically four ways in which a person can come into contact with infectious agents which are: contact with the skin or mucus membranes, ingestion, inhalation, and inoculation. Contact with skin or mucus membranes

Spilled material can come into direct contact with the skin as can droplets produced by pipetting, removal of screw caps, and vortex mixing of unsealed tubes.

The control of a contact exposure is accomplished through:

- Wearing appropriate protective clothing such as a face shield, gloves, safety glasses, a mask, and laboratory coats.
- Using absorbent paper on the work bench
- Performing all procedures carefully, and frequently wiping work surfaces with a disinfectant.
- Keeping all non-essential items away from the area where work is being performed to protect personal items from contamination.
- Handling and properly storing the contaminated waste to prevent contact exposure of lab personnel as well as housekeeping staff and waste handlers.

9.2.1 Ingestion

Ingestion may occur from mouth pipetting or splashing from a container into the mouth or by contaminating the hands and then touching the mouth or items such as a coffee cup, food, or lip balm, that go into the mouth.

The control of an ingestion exposure is accomplished through:

- Using mechanical pipetting devices whenever pipetting
- Practicing good personal hygiene, such as washing hands frequently throughout the day and not eating or drinking in the work area.
- Not storing food in refrigerators that contain hazardous materials or in labs where work with infectious agents is being performed.

9.2.2 Inhalation

It is generally known that aerosols are the primary means by which infectious diseases are spread and contracted. An aerosol can be either a liquid or a dry particle. An aerosol with a diameter of just five microns or less can easily be inhaled and carried to the alveoli of the lungs. These aerosols can remain airborne for a long period of time and can spread over large distances, especially after entering the ventilation system. Particles with a diameter larger than five microns tend to settle rapidly and can contaminate the skin or other surfaces.

There are many common laboratory procedures that can create aerosols. Examples include: centrifuging, heating inoculating loops, using blenders, blowing out the last drop in a pipette, and changing animal bedding.

The control of inhalation exposure is accomplished by a combination of using the appropriate safety equipment such as biological safety cabinets and by performing procedures carefully to minimize the creation of aerosols.

9.2.3 Inoculation

Inoculation normally occurs with a needle and syringe. Exercise extreme caution whenever using a needle. Restrict needle use; whenever an alternative to a needle is possible, it should be used. Inoculation can also occur through animal bites and other sharps such as razor blades.

The control of an inoculation hazard is accomplished by the safe use, handling, and storage of needles and other sharps. After using a needle, do not recap, bend, break or remove it from the syringe. The needle and other sharps should simply be placed into a sharps container to prevent any injuries.

9.3 Biosafety Levels

The Biosafety Levels (BSL) scale is used to label the level of precaution that is required to isolate biological substances in a confined area. A BSL is based on the potential hazard of the agent and the function of the lab it is in. BSL1 is for work with agents that pose the least hazard and BSL4 is for work with agents that pose the greatest hazard. Only BSL1 through 3 are included here because there are no BSL4 labs in the SQU. Below, are examples of organisms that fall into a particular BSL classification. Keep in mind that the BSL used for a particular organism may actually change depending on the procedures being performed and the amount of cultures involved.

All work with microbiological agents should follow the US Center for Disease Control and Prevention (CDC) and US National Institute of Health (NIH) guidelines for the appropriate BSL. At a minimum, research and instructional labs conducting work with microbiological agents should follow the guidelines for BSL1.

9.3.1 Biosafety Level 1

BSL1 is suitable for work involving agents not known to cause disease in healthy adult humans, and of minimal potential hazard to laboratory personnel and the environment.

Examples of BSL1 Agents:

- *Bacillus subtilis*
- *Naegleria gruberi*
- Infectious Canine Hepatitis Virus

For this biosafety level the following safety rules apply:

- The laboratory is not necessarily separated from the other laboratories and offices in the building.
- Work is generally conducted on open bench tops using standard microbiological practices.
- Special containment equipment or facility design is not required nor generally used.
- Laboratory personnel have specific training in the procedures conducted in the laboratory and are supervised by a scientist with general training in microbiology or a related science.

9.3.1.1 Standard Microbiological Practices for BSL1

- Access to the laboratory is limited or restricted at the discretion of the laboratory supervisor when experiments or work with cultures and specimens is in progress.
- Persons wash their hands after they handle viable materials and animals, after removing gloves, and before leaving the laboratory.
- Eating, drinking, handling contact lenses, and applying cosmetics are not permitted in work areas where there is reasonable likelihood of exposure to potentially infectious materials.

- Persons who wear contact lenses in laboratories should also wear goggles or a face shield.
- Food is stored outside the work area in cabinets or refrigerators labeled and used for this purpose only. Mouth pipetting is prohibited; mechanical pipetting devices are used.
- All procedures are performed carefully to minimize the creation of splashes or aerosols.
- Work surfaces are decontaminated at least once a day and after any spill of viable material.
- All cultures, stocks, and other regulated wastes are decontaminated before disposal by an approved decontamination method, such as autoclaving. Materials to be decontaminated outside of the immediate laboratory are to be placed in a durable, leak-proof container and closed for transport from the laboratory.
- An insect and rodent control program is in effect.

9.3.1.2 Safety Equipment (Primary Barriers) BSL 1

Special containment devices or equipment such as a biological safety cabinet are generally not required for manipulations of agents assigned to BSL1. It is recommended that laboratory coats, gowns, or uniforms be worn to prevent contamination or soiling of street clothes.

Gloves should be worn if the skin on the hands is broken or if a rash exists. Protective eyewear should be worn for anticipated splashes of microorganisms or other hazardous materials to the face.

9.3.1.3 Laboratory Facilities (Secondary Barriers) BSL 1

- Each laboratory contains a sink for hand washing.
- The laboratory is designed so that it can be easily cleaned. Rugs in laboratories are not appropriate and should not be used because proper decontamination following a spill is extremely difficult to achieve.
- Bench tops are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.
- Laboratory furniture is sturdy. Spaces between benches, cabinets, and equipment are accessible for cleaning.
- If the laboratory has windows that open, they are fitted with fly-proof screens.

9.3.2 Biosafety Level 2

BSL2 is similar to Level 1 and is suitable for work involving agents of moderate potential hazard to personnel and the environment.

Examples of BSL2 Agents:

- *Bordetella pertussis* *Cryptococcus neoformans*
- *Clostridium tetani* *Mycobacterium leprae*
- *Shigella* spp. Human Immunodeficiency Virus
- Human blood

It differs from biosafety level 1 in that:

- Laboratory personnel have specific training in handling pathogenic agents and are directed by scientists.
- Access to the laboratory is limited when work is being conducted.
- Extreme precautions are taken with contaminated sharp items
- Certain procedures in which infectious aerosols or splashes may be created are conducted in biological safety cabinets or other physical containment equipment.

9.3.2.1 Standard Microbiological Practices for BSL2

In addition to all the requirements for BSL1, work at BSL2 requires special practices:

- Access to the laboratory is limited or restricted by the laboratory supervisor when work with infectious agents is in progress.
- Persons who are at increased risk of acquiring infection (e.g. immunocompromised) or for whom infection may be unusually hazardous are not allowed in the laboratory
- The laboratory director has final responsibility for assessing each circumstance and determining who may enter or work in the laboratory.
- Policies and procedures are established whereby only persons who have been advised of the potential hazard and meet specific entry requirements (e.g., immunization) enter the laboratory or animal rooms.
- A hazard warning sign incorporating the universal biohazard symbol is posted on the access door to the laboratory work area. The hazard warning sign identifies the infectious agent, lists the name and telephone number of the laboratory director or other responsible person(s), and indicates the special requirement(s) for entering the laboratory.
- Laboratory personnel receive appropriate immunizations or tests for the agents handled or potentially present in the laboratory (e.g., hepatitis B vaccine or TB skin testing).
- When appropriate, baseline serum samples for laboratory and other at-risk personnel are collected and stored. Additional serum specimens may be collected periodically, depending on the agents handled or the function of the facility.
- A site-specific biosafety manual is prepared or adopted in addition to this Laboratory Safety manual. Personnel are advised of special hazards and are required to read and follow instructions on practices and procedures.
- Laboratory personnel receive appropriate training on the potential hazards associated with the work involved, the necessary precautions to prevent exposures, and the exposure evaluation procedures. Personnel receive annual updates, or additional training as necessary for procedural or policy changes.
- A high degree of precaution must always be taken with any contaminated sharp item, including needles and syringes, slides, pipettes, capillary tubes, and scalpels. Needles and syringes or other sharp instruments should be restricted for use only when there is no alternative, such as parenteral injection, phlebotomy, or aspiration of fluids from laboratory animals and diaphragm bottles. Plastic ware should be substituted for glassware whenever possible.
- Only needle-locking syringes or disposable syringe-needle units (i.e., needle is integral to the syringe) are used for the injection or aspiration of infectious materials. Used disposable needles must not be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal; rather, they must be carefully placed in conveniently located puncture-resistant containers used for sharps disposal.
- Non-disposable sharps must be placed in a hard-walled container for transport to a processing area for decontamination, preferably by autoclaving.
- Broken glassware must not be handled directly by hand, but must be removed by mechanical means such as a brush and dustpan, tongs, or forceps.
- Cultures, tissues, or specimens of body fluids are placed in a container that prevents leakage during collection, handling, processing, storage, transport, or shipping.
- Laboratory equipment and work surfaces should be decontaminated with an appropriate disinfectant on a routine basis, after work with infectious materials is finished, and especially after overt spills, splashes, or other contamination by infectious materials.

- Contaminated equipment must be decontaminated before it is sent for repair or maintenance.
- Spills and accidents which result in overt exposures to infectious materials are immediately reported to the laboratory director.
- Medical evaluation, surveillance, and treatment are provided as appropriate and written records are maintained.
- Animals not involved in work being performed are not permitted in the laboratory.

9.3.2.2 Safety Equipment (Primary Barriers) BSL2

- Biological safety cabinets (BSC), preferably Class II, or other appropriate personal protective equipment or physical containment devices are used whenever:
- There is a potential for creating infectious aerosols or splashes
- High concentrations or large volumes of infectious agents are used.
- Face protection (e.g. goggles, mask, and face shield) is used when the microorganisms must be manipulated outside the BSC.
- Protective laboratory coats, gowns, smocks, or uniforms designated for lab use are worn while in the laboratory. Protective clothing should be removed and left in the laboratory before leaving for non-laboratory areas (e.g., cafeteria, library, and administrative offices). Protective clothing should never be taken home by personnel.
- Gloves are worn when handling infected animals and when hands may contact infectious materials, contaminated surfaces, or equipment. Wearing two pairs of gloves may be appropriate; if a spill or splatter occurs; the hand will be protected after the contaminated glove is removed. Gloves are disposed of when contaminated, removed when work with infectious materials is completed, and are not worn outside the laboratory. Disposable gloves are not washed or reused.

9.3.2.3 Laboratory Facilities (Secondary Barriers) BSL2

- A method for decontamination of infectious or regulated laboratory wastes is available (e.g., autoclave, chemical disinfection, incinerator, or other approved decontamination system).
- An eyewash facility is readily available.

9.3.3 Biosafety Level 3

BSL3 is applicable to clinical, diagnostic, teaching, research, or production facilities in which work is done with indigenous or exotic agents that may cause serious or potentially lethal disease as a result of exposure by inhalation.

Examples of BSL3 Agents:

- *Mycobacterium tuberculosis*
- Vesicular Stomatitis Virus
- Yellow Fever Virus
- *Francisella tularensis* - during manipulations of cultures and for experimental animal studies
- *Coxiella burnetii* - for activities involving inoculation, incubation, and harvesting of embryonated eggs or cell cultures, necropsy of infected animals, and manipulation of infected tissues

For BSL3 environments, it's important that:

- Laboratory personnel have specific training in handling pathogenic and potentially lethal agents and are supervised by scientists who are experienced in working with these agents.

- All procedures involving the manipulation of infectious materials are conducted within biological safety cabinets or other physical containment devices or by personnel wearing appropriate personal protective clothing and equipment.
- The laboratory has special engineering and design features.
- It is recognized that many existing facilities may not have all the facility safeguards recommended for BSL3 (e.g., access zone, sealed penetrations, and directional airflow). In these circumstances, acceptable safety may be achieved for routine or repetitive operations (e.g., diagnostic procedures involving the propagation of an agent for identification, typing, and susceptibility testing) in BSL2 facilities. However, the recommended Standard Microbiological Practices, Special Practices, and Safety Equipment for BSL3 must be rigorously followed.

Standard Microbiological Practices for BSL3:

- In addition to all the requirements for BSL2, work at BSL3 requires special practices:
- Laboratory doors are kept closed when experiments are in progress.
- The laboratory director controls access to the laboratory and restricts access to persons whose presence is required for program or support purposes.
- The laboratory director is responsible for ensuring that before working with organisms at BSL3, all personnel demonstrate proficiency in standard microbiological practices and techniques, and in the practices and operations specific to the laboratory facility
- No work in open vessels is conducted on the open bench but in biological safety cabinets or other physical containment devices within the containment module.
- All potentially contaminated waste materials (e.g., gloves and lab coats) are decontaminated before disposal or reuse.
- Spills of infectious materials are decontaminated, contained, and cleaned by appropriate professional staff, or others properly trained and equipped to work with concentrated infectious material.

9.3.3.1 Safety Equipment (Primary Barriers) BSL3

Properly maintained biological safety cabinets are used (Class II or III) for all manipulation of infectious materials.

- Outside of a BSC, appropriate combinations of personal protective equipment are used (e.g., special protective clothing, masks, gloves, face protection, or respirators), in combination with physical containment devices (e.g., centrifuge safety cups, sealed centrifuge rotors, or containment caging for animals).
- Equipment must be used for manipulation of cultures and of those clinical or environmental materials that may be a source of infectious aerosols: the aerosol challenge of experimental animals; harvesting of tissues or fluids from infected animals and embryonated eggs; and necropsy of infected animals.
- Respiratory protection is worn when aerosols cannot be safely contained (i.e., outside of a biological safety cabinet), and in rooms containing infected animals.
- Protective laboratory clothing such as solid-front or wrap-around gowns, scrub suits, or coveralls must be worn inside the laboratory only. Reusable laboratory clothing is to be decontaminated before being laundered.

9.3.3.2 Laboratory Facilities (Secondary Barriers) BSL3

- The laboratory is separate from areas that are open to unrestricted traffic flow within the building. Passage through two sets of self-closing doors is the basic requirement for entry into the laboratory from access corridors or other contiguous areas. A clothes change room (shower optional) may be included in the passageway.
- Each laboratory contains a sink for hand washing. The sink is foot, elbow, or automatically operated and is located near the laboratory exit door.

- The interior surfaces of walls, floors, and ceilings are water-resistant so that they can be easily cleaned. Penetrations in these surfaces are sealed or capable of being sealed to facilitate decontamination.
- Windows in the laboratory are closed and sealed.
- A method for decontaminating all laboratory wastes is available, preferably within the laboratory (i.e., autoclave, chemical disinfection, incineration, or other approved decontamination method).
- A ducted exhaust air ventilation system is provided. This system creates directional airflow that draws air from "clean" areas into the laboratory toward "contaminated" areas. The exhaust air is not recirculated to any other area of the building, and is discharged to the outside with filtration and other treatment optional. The outside exhaust must be dispersed away from occupied areas and air intakes. Laboratory personnel must ensure the proper direction of airflow (into the laboratory).
- The High Efficiency Particulate Air (HEPA) filtered exhaust air from Class II or Class III biological safety cabinets is discharged directly to the outside or through the building exhaust system. If the HEPA filtered exhaust air from Class II or Class III biological safety cabinets is to be discharged to the outside through the building exhaust air system, it should be connected to this system in a manner that avoids any interference with the air balance of the cabinets or building exhaust system. Exhaust air from Class II biological safety cabinets may be recirculated within the laboratory if the cabinet is tested and certified
- Continuous flow centrifuges or other equipment that may produce aerosols are contained in devices that exhaust air through HEPA filters before discharge into the laboratory.
- Vacuum lines are protected with liquid disinfectant traps and HEPA filters, or their equivalent, which are routinely maintained and replaced as needed.

9.4 Laboratory Equipment

9.4.1 Biological Safety Cabinet

- A biological safety cabinet (BSC) is used as a primary barrier against exposure to infectious biological agents. A BSC has High Efficiency Particulate Air (HEPA) filters. The airflow in a BSC is laminar, i.e. the air moves with uniform velocity in one direction along parallel flow lines. A BSC must be used in conjunction with safe laboratory techniques, because potentially dangerous aerosols can still escape.
- Depending on the design, a BSC may be vented to the outside or the air may be exhausted into the room. BSCs are not a chemical fume hood. A percentage of the air is recirculated in most types of BSCs. Therefore, the levels of explosive, flammable, or toxic materials will be concentrated within the cabinet. HEPA filters only trap particulates, allowing any contaminant in non-particulate form to pass through the filter.

9.4.1.1 Biological safety Cabinets classes

9.4.1.1.1 Class I BSCs

In Class I BSCs, the exhaust air is HEPA filtered so the user and the environment are protected, but the product inside the cabinet is not. With a Class I cabinet, the user's hands and arms while inside the cabinet are exposed to the infectious materials. The Class I BSC is designed for general microbiological research with low to moderate risk agents, and is useful for containment of mixers, blenders, and other equipment.

9.4.1.1.2 Class II BSCs

There are different types of Class II BSCs, but they all offer HEPA filtered supply and exhaust air. This type of cabinet will protect the user, environment, and the product and is suitable for work assigned to Biosafety Levels 1, 2, or 3. Class II cabinets are the class most commonly used.

9.4.1.1.3 Class III BSCs

These cabinets are often referred to as glove boxes. The Class III cabinet is gas-tight and under negative pressure. All work in the cabinet is performed through rubber gloves attached to entry portals. The Class III cabinet offers the highest level of protection from infectious aerosols. Class III cabinets are most suitable for work with agents that require BSL3 or BSL4 containment.

9.4.1.2 Proper Use of BSCs

- Wipe the surface of the BSC with a suitable disinfectant, e.g., 70% alcohol or a 1:10 bleach solution BEFORE AND AFTER USE.
- Place everything you will need inside the cabinet before beginning work, including a waste container. You should not have to penetrate the air barrier of the cabinet once work has begun.
- Do not place anything on the air intake grilles as this will block the air supply.
- A sign can be posted on the door of the room stating that the cabinet is in use.
- Prevent unnecessary opening and closing of doors as this will disrupt the airflow of the cabinet.
- Always wear a lab coat while using the cabinet and conduct your work at least four inches inside the cabinet.
- Place burners to the rear of the cabinet to reduce air turbulence.
- Place a disinfectant-soaked towel on the work surface to contain any splatters or small spills that might occur.
- Do not work in the BSC while the ultraviolet light is on. Ultraviolet light can quickly injure the eye.
- When finished with your work procedure, cover the waste container and decontaminate the surfaces of any equipment that is not enclosed.
- Operate the cabinet for five minutes before and after performing any work in it in order to purge airborne contaminants.
- Remove the equipment from the cabinet and decontaminate the work surface.
- Thoroughly wash your hands and arms.

9.4.1.3 Maintenance and Certification of BSCs

A BSC must be certified after it has been newly installed and maintained and certified annually and after it has been moved, or had a filter replaced. Technical Affairs Department is responsible for this.

9.4.2 Clean Benches

Clean benches (a.k.a. laminar flow hoods) are not considered laboratory safety equipment. However, they deserve mention because they may be confused with BSCs. A clean bench is designed to protect the product from contamination, but it does not protect the user. The direction of airflow in a clean bench is towards the user.

9.4.3 Pipetting Devices

Mouth pipetting should never be used, even for innocuous materials, because you may at some time mistakenly mouth pipette something that is hazardous. Only mechanical pipetting should be used.

To minimize aerosol production, a pipette should be drained with the tip against the inner wall of the receiving vessel. Never forcibly expel any hazardous material from a pipette.

9.4.4 Centrifuges, Sonicators, Homogenizers, and Blenders

All of these instruments can create aerosols and this must be remembered with each use. The necessary precautions taken will depend upon what is being used in these instruments. If it's

hazardous materials such as carcinogens, highly toxic, or infectious agents, then precautions must be taken to prevent exposure of lab personnel to the aerosols or liquids.

9.4.4.1 Centrifuges

- Depending on the nature of the material being used in these instruments, it may be necessary for them to be used or opened only in a biological safety cabinet.
- Centrifuges that have sealed buckets, safety trunnion cups, or sealed heads are effective at preventing the escape of aerosols and liquids. The potential for exposing people to a hazardous material used in a centrifuge is great if the centrifuge tube breaks without the use of the safety features mentioned above.
- Routinely inspect your centrifuge to ensure leakage is not occurring. An indicator such as fluorescein can be used to detect leaks. The fluorescein can be added to water and then centrifuged as you would other materials. An ultraviolet light can then be used to detect the fluorescein's presence on work surfaces, floors, and walls.

9.4.4.2 Sonicators, Homogenizers, and Blenders

- Depending on the nature of the material being used in these instruments, it may be necessary for them to be used or opened only in a biological safety cabinet.
- When working with infectious agents, blenders should have leak proof bearings and a tight-fitting, gasketed lid. Inspect the lid and gaskets routinely to ensure they are in good condition.
- Hearing protection may be required while using a sonicator.

9.5 Personal Protective Clothing

- The type of personal protective clothing required in microbiological labs will depend upon the assigned Biosafety Level for that lab (see Section 2 of this chapter regarding Biosafety Levels).
- The protective clothing suitable for a typical undergraduate microbiology lab is a lab coat, to prevent street clothes from getting soiled, and latex or vinyl gloves. Long hair must be restrained if bunsen burners are in use. Only closed shoes, not, sandals are allowed.
- should then be discarded. In between glove changes, thoroughly wash your hands and arms. For a typical graduate level teaching or research microbiology lab (which are often a BSL2), lab coats or similar protective clothing should be worn while in the lab, and gloves must be worn while handling any infectious materials. Additionally, if the work involves human blood, a face shield, safety glasses or goggles, and a mask may be required if there is a potential for splash.
- A research lab that is assigned a Biosafety Level 3 has additional requirements for personal protective clothing:
- laboratory clothing that protects street clothing must be worn, e.g., a solid-front or wrap-around gown.
- Typical lab coats which button down the front are not acceptable because they do not provide full protection.
- Gloves must be worn in the lab, and respirators worn in rooms containing infected animals.
- Whenever personal protective clothing becomes contaminated, it must be removed and replaced.
- Leave protective clothing in the lab and do not wear it to other non-lab areas.
- Disposable gloves are meant to be used only once.

9.6 Human Blood borne Pathogens

- A human blood borne pathogen is a pathogenic microorganism, present in human blood that can cause disease in humans (e.g. HIV, Hepatitis B).
- If during the course of work a potential exists for coming in contact with human blood you must receive training on blood borne pathogens. The following Universal Precautions should be practiced whenever coming in contact with human blood:
- Use appropriate barrier precautions to prevent skin and mucus membrane exposure when contact with blood is anticipated.
- Always wear gloves.
- Wear masks and protective eyewear or face shields to prevent exposure to the eyes, mouth, and nose during procedures that are likely to result in droplets of blood.
- Wear gowns or aprons during procedures that are likely to result in splashes of blood.
- Remove all protective clothing before leaving the laboratory.
- Wash hands and other skin surfaces immediately if contaminated with blood and after the removal of gloves.
- Limit the use of needles to where there is no alternative and take precautions to prevent injuries by needles and other sharps.
- Needles should not be recapped, removed from the syringe, or otherwise manipulated by hand.
- Place needles and other sharps into puncture-resistant containers.
- Keep all specimens of blood in well-constructed containers with a secure lid to prevent leakage during transport.
- Use biological safety cabinets whenever procedures that have a high potential for generating droplets are conducted.
- Never mouth pipette.
- Decontaminate laboratory work surfaces after a spill of blood and when work activities are completed. (Appendix D)

Note: Some animals can also carry pathogens that can be transmitted to humans through contact with their body fluids, similar to human blood borne pathogens. This contact can occur through biting, spitting, or contamination of broken skin or mucus membranes with bodily secretions from the animal. Therefore, when working with animals that are capable of transmitting disease to humans, take necessary precautions to protect yourself (i.e. wear gloves, masks, and laboratory coats whenever entering an area where these animals are housed).

10 RADIATION HAZARDS

10.1 Introduction

There are particular risks when working with radiation of all types. All persons working with radiation particularly with ionizing radiation are subject to potential risks of exposure which may be extremely harmful if sufficient safety precautions are not taken.

10.2 Non-ionizing Radiation

10.2.1 Ultraviolet radiation (UV)

Ultraviolet radiation has multiple applications in the university (e.g. killing bacteria, ultra-violet quartz-halogen lamps). Ultra- violet radiation lies in the band of wavelengths from 400 to 100nm.

10.2.1.1 UV radiation hazards

UV are not very penetrating radiation. The hazard to health results from sources emitting radiation with wave length longer than 200nm. The biological effects of UV radiation with the wavelength and are mainly due to chemical reactions they produce in the skin and the eyes. Short exposures from ultra-violet radiation can damage the eyes or the skin and injury can result even if one does not look directly at the light. The energy is adsorbed in the outer layers of the eye and conjunctivitis results several hours after exposure, persisting for several days. Wave length greater than 270nm may cause inflammation in the cornea called keratitis, which is very painful; and chronic exposure may lead to cataract.

10.2.1.2 UV radiation safety measures

All UV radiation hazards may be controlled by control measures. Firstly, by applying engineering controls (e.g. using screens, filters, interlock), if at all possible; then using administrative controls (e.g. limitation of access and exposure time, hazard awareness training, warning signs); and finally, if the hazard still poses risk, by using personnel protective equipment (PPE) (e.g. goggles, gloves)

As for any type of radiation, when working with UV radiation sources protection against overexposure is accomplished by the following:

- Time: Minimize the time of exposure
- Distance: Maximize the distance from the source
- Shielding: Utilize effecting shielding material

10.2.2 Lasers

Lasers emit highly collimated monochromatic beam of extremely intense electromagnetic radiation when energized. The radiation emitted by lasers range from the ultraviolet to the infrared regions of the electromagnetic spectrum. The range of commonly available lasers is from 200 nanometers to 10.6 micrometers. Laser radiation may be emitted as a continuous wave or in pulses.

The primary mechanism of damage for most lasers is thermal. Photochemical damage may occur when dealing with lasers operating in the ultraviolet region of the spectrum. The intensity of the radiation that may be emitted and the associated potential hazards depend upon the type of laser, the wave length of the beam, and the uses of the laser. However, in virtually all cases, exposure to the direct beam or even to the reflected radiation must be regarded as hazardous.

10.2.2.1 Potential laser Hazards

Laser users encounter many hazards in the use of a laser. Unless precautions are used by the user to minimize these hazards, there could be significant consequences.

- **Beam Hazards:** The direct beam, diffuse reflection or specular reflection from a laser can damage eye and the skin. These beams from class 3b and 4 lasers may lead to blindness, skin burn, and even to fires. Diffuse reflection from class 4 lasers may also cause these hazards.
- **Hazard to the eye:** Laser radiation may produce burns of the cornea and the retina. When such radiation enters the eye, it concentrates on the retina and may produce a permanent blind spot. The location and extend of these injuries depends on the wavelength and the laser classification. Although the blink reaction gives protection from visible class 1, 2 and 3A lasers, class 3B and 4 require special precautions. These injuries may be caused by both acute and chronic exposures. All eye hazards can be controlled by using laser safety eyewear that is appropriate for the specific laser system, or by other engineering safety controls.
- **Skin hazard:** Acute exposure to high levels laser radiation, particularly in the infrared region may lead to skin burns. Laser from ultraviolet region may lead to erythema, skin cancer, and accelerated skin aging. Skin hazard can be controlled by shielding the beam and the reflections or covering the skin by opaque materials.
- **Fire Hazard:** Combustible materials can catch fire if exposed to the laser beam or to the scatter of class 4 lasers. Other fire hazards include electrical components and the flammability of class 4 laser beam enclosures. The risks of fire can be reduced by the use of fire resistant materials in the vicinity of radiation beam and the scatter of class 4 lasers.
- **Electrical Hazards:** Laser systems, especially the high powered ones, pose potentially lethal electrical hazards. High voltage components such as power supplies and discharge capacitors may present an electrical hazard.

Some gases and chemical solutions used in laser systems may be hazardous and toxic. In addition, laser induced reactions may produce hazardous particles or gases around the laser system.

Solvents used in dye lasers may be extremely flammable and ignited by high voltage components or flash lamps.

10.2.2.2 General safety procedures

Class 3B and 4 laser equipment must not be operated by inexperienced persons unless under the immediate personal supervision of an experienced licensed operator. These safety precautions should be taken whenever working with any Class 3b or Class 4 lasers:

- Do not enter a room where a laser is used unless authorized to do so.
- Do not work with lasers unless you are trained to do so.
- Never look directly into the beam.
- Make sure that you are using the proper safety device for the unit before energizing any laser (e.g. opaque shielding, goggles, face shields, door interlock, and ventilation for toxic material).
- Use low power or neutral density filters during alignment or other set up procedures.
- Position the beam path well above or below eye level.
- Use proper eyewear during beam alignment procedure and use the lowest practical power levels.
- Make sure that the pulsed laser unit cannot be energized inadvertently (i.e. discharge capacitors and turn off power before leaving the laser unit unattended).
- Install warning signs and lights outside the door and make sure that the light is properly functioning when the laser is in operation
- Remove from the room any reflective or partially reflective surface (e.g. watch, jewelry, metallic buckles, mirror)
- Verify that the laser warning signs are properly working when the laser is activated.

- When working with class 4, use a suitable shielding between the laser beam and the personnel or the flammable surface.
- Use door interlocks to terminate the laser beam when door is opened.
- Additional local working rules, specific for each laser must, where necessary, be documented to ensure the safe operation of the unit.
- working local rules must be
- Do not look into the laser beam. (For any class of laser this is a hazardous practice)
- The laser must be used within a controlled area from which the laser beam cannot escape.
- Ensure that the controlled area is clearly defined with signs, and all windows are blocked etc. or room without window for class 4 lasers.
- Report all accidents and incidents to the SQU Safety and Security Committee.

10.2.2.3 *Special Laser Precautions*

Beam alignment procedure is known to cause most laser injuries. Very often those performing this procedure do not wear the appropriate eye protective wear. These accidents occur mainly with visible laser light as the procedure for invisible laser (e.g. IR, UV) use indirect beam viewing. Wearing laser protective eye wear may minimize the injury. Special alignment glasses exist that filter out the beam that may cause injury. If these are not available regular eye protective wear must be worn during beam alignment.

More information on special laser precautions, particularly related to specific type of lasers, can be found in the university radiation Safety manual.

10.2.2.4 *Laser accidents*

In the event of accidental exposure to laser radiation you should:

- Immediately notify the department RPO.
- Go to Accident and Emergency Department (ANE) for an urgent eye examination.
- File an incident report to be given to the RPO

The RPO should investigate the source of exposure and file an incident report to the SQU Safety and Security Committee. A copy of the report should be filed in the concerned Department.

10.2.3 **Microwave**

Microwave ovens are extensively used throughout the University. Their use varies from heating food to more elaborate procedures in the research laboratories.

Persons using microwave ovens should be aware of the possible "radiation hazards" from damaged or altered microwave ovens that may result in leak of microwave energy.

The radiation risks to people from microwave ovens would result if the microwave radiation resulting from escape of leakage from the oven is such that it can cause heating in tissue resulting in burns. The eyes are especially sensitive to heating from microwaves. However, if microwave radiation is sufficiently intense, it may heat or even burn any body tissue.

10.2.3.1 *Microwave radiation leakage standard*

The standard for radiation leakage is less than five milliwatts per centimeter squared at five centimeters from the oven over the lifetime of the unit. This radiation limit is well below the level at which heating or burning of human tissue would occur. In addition, the standard is required that oven doors be interlocked during oven operation.

10.2.3.2 *Microwave hazards*

Injuries are mainly caused by handling hot items from microwave ovens; steam generated from items can cause very serious and painful burns. Explosions may occur in microwave ovens from pressure built up in sealed containers or from ignition of volatile materials.

10.2.3.3 Microwave safety measures:

The following are general microwave operation radiation safety measures.

- Always follow the manufacturers' instructions.
- Never operate an oven that produces microwaves with the door open.
- Beware of heat and steam generated from substances heated in a microwave oven.
- Never look directly into a covered container as the cover is removed. Always allow the steam to escape first.
- Do not alter or modify (e.g. disable the interlocks, remove the doors) microwave ovens as it may increase the leaked microwave at dangerous levels.

Whenever microwaves are used, microwave safety rules must be included in the departmental local safety rules.

10.3 Ionizing Radiation

Radioactive materials and sources emitting ionizing radiation are used throughout the University, particularly in the Hospital.

It is well known that ionizing radiation has a potentially harmful effect. The international Commission on radiological Protection recommends a system of dose limitation, to ensure that every exposure to ionizing radiation is justified in relation to its benefits. They proposed the following system of dose limitation:

- Justification: No practice shall be adopted unless its introduction produces positive net benefit
- Optimization: all exposures are kept as low as reasonably Achievable (ALARA principle)
- Limitation: the dose equivalent to individuals shall not exceed the recommended limits.

10.3.1.1 Radiation safety

The safety measures to be taken to ensure that radiation protection is adequate are twofold; administrative measures and practical procedures.

10.3.1.2 Administrative measures

The management of Sultan Qaboos University (SQU) carry the ultimate responsibility for ensuring for all employees at work place such that radiation exposure arising from external (e.g. x-ray, γ -ray) or internal radiation (e.g. ingestion, inhalation of radioactive substance) are kept as low as reasonably achievable (ALARA principle, ICRP60), and doses not exceed dose limits specified for the individuals. However, all staff working with ionizing radiations must be responsible for their own safe practices and should at all times strive to reduce radiation dose levels in accordance with the **ALARA** principle both to themselves and to others who may be affected by their work.

- Committees: In accordance with the University Qarar No. 143/2008 regarding Safety and Security Committee reform, which took effect on 16/3/2008, each college nominated a Safety and security committee and the SQUH a Health, Safety and Security Committee. These committees are responsible of all safety issues including radiation safety.
- Radiation Safety Officer (RSO): The RSO provides professional advice and assistance in all aspects of radiation safety to radiation workers and to coordinate administration of the radiation safety program. The RSO is responsible for keeping procedures and practices for the use of radiation up to date, in order to keep employees' radiation exposures As Low As Reasonably Achievable (ALARA).
- Radiation Protection Supervisor (RPS): The RPS is nominated by the heads of departments where ionizing radiation is used. He/she enforces the Local Rules in his/her department to ensure that radiation doses to staff and patients are as low as reasonably practicable.

10.3.1.3 Practical Measures

10.3.1.3.1 General

- All work involving radiation sources should be contained so as to expose staff and members of the public to the minimum dose reasonable achievable.
- Protection from radiation can be achieved by distance, shielding and reduction of exposure time. Proper siting of equipment, particularly powerful x-ray sources, in a room with suitable barriers is essential.
- Working areas should be labeled as controlled or supervised areas:
 - Controlled area is one where it is possible to receive more than 30% of the dose limit. Access to this area should be restricted by warning signs and by visual indication when x-ray machine is energized to emit radiation.
 - Supervised area is one in which it is possible to receive more than 10% of the dose limit but less than 30%.

10.3.1.3.2 Monitoring of staff

- Thermoluminescent dosimeters (TLD) badges should be worn by all staff that needs to enter controlled areas
- Controlled and supervised areas should be regularly surveyed to prevent that staff receive more than the dose limit. In addition

10.3.1.3.3 Local Rules

Every Department using ionizing radiation should have written local rules.

They should set-up clearly and precisely the procedures in force along with the name of the Radiation Protection Supervisor. They must include the description of the controlled and supervised areas. These local rules must incorporate a system of work under which personnel entering controlled areas must operate.

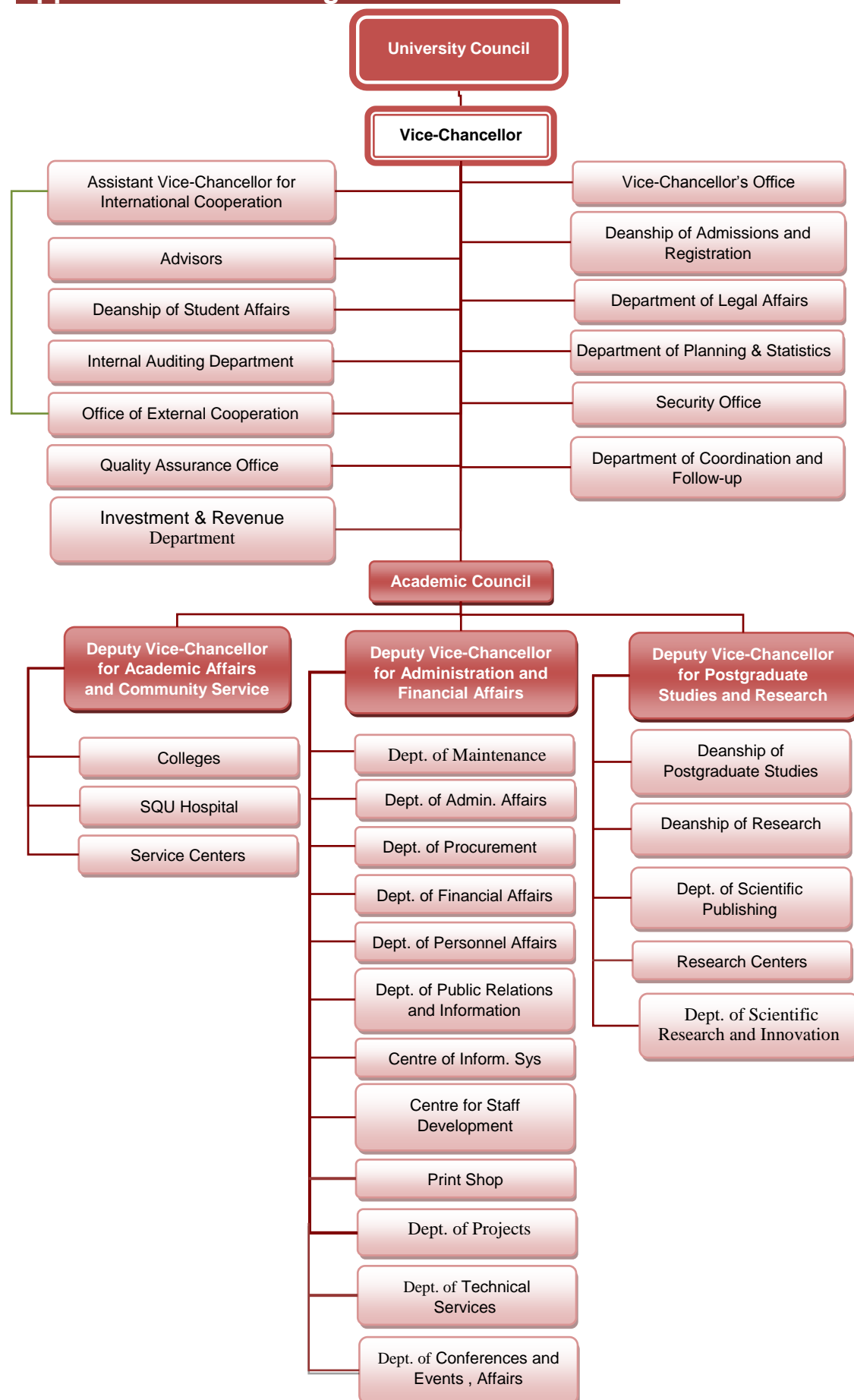
11 WASTE DISPOSAL

There are several types of waste produced in the University. All need to be handled, stored, treated and disposed of properly and in a safe manner in accordance with the latest SQU Waste Disposal Policy (refer to SQU Waste Disposal Policy, edition 2009, manual for more detailed information).

The University should aspire to minimize the amount of waste it generates. Four key principles can be applied to do this:

- Avoid generating waste in the first place: simply put, this means that we should manage our processes to reduce the amount of waste we create.
- Minimize waste when we do create it: There are a number of simple things that can be done to reduce the amount of waste generated (e.g. order the smallest quantity of chemical needed for a project, use rechargeable batteries, chose durable items which can be easily repaired, avoid disposable items)
- Reuse waste: for example, unwanted, not expired chemicals can be passed on to other research groups or even to other Colleges instead of being thrown out.
- Recycle waste: for example recycling plastics and paper, solvents such as xylene and alcohol can be distilled and reused. For more information regarding recycling waste contact the SQU Health and Safety Committee.

Appendix A : SQU Organizational Structure



Appendix B : Mercury Spill Kit

It can purchased or alternatively can be assembled with the following components:

- Protective gloves
- Mercury suction pump or disposable pipettes to recover small droplets
- Elemental zinc powder (or commercial amalgam material)
- Dilute sulfuric acid (5-10%) in spray bottle,
- Sponge or tool to work amalgam,
- Plastic trash bag
- Plastic container (for amalgam)
- Plastic sealed vial for recovered mercury.

Appendix C : Accident Reporting

- ALL injuries, including minor injuries, should be reported to the Chairman of SQU Safety and Security Committee (Use accident reporting form in Appendix Forms).
- All major accidents should be investigated by safety Office.
- All minor accidents should be investigated. Taking corrective action as a result of a minor accident may keep a major incident from happening.
- Employees should understand that the purpose of reporting and documenting accidents is not to affix blame, but instead to determine the cause of the accident so that similar incidents may be prevented in the future.
- If the accident involves overexposure to hazardous materials, an Employee Exposure Report shall also be prepared and send to SQU Safety and Security Committee.

Appendix D : Procedure for Cleaning Blood Spills on Hard Surfaces

- Isolate the area, if possible.
- Wear gloves and other protective clothing as needed.
- Remove visible blood with disposable towels by putting towels over the spill to absorb the liquid.
- Place contaminated towels in a plastic waste disposal bag.
- Decontaminate the area with an appropriate germicide according to manufacturer's directions.
- All contaminated towels and gloves should be double-bagged for disposal and labeled with the biohazard symbol.

Procedure for cleaning Blood Spills on Carpeting

- Use only a registered germicide. Read and follow manufacturer's instructions. Do not use chlorine bleach solution on carpet.
- Isolate the area, if possible.
- Wear gloves and other appropriate clothing.
- Procedure for small spills on carpets:
 - Soak the spill with enough disinfectant to cover the spot.
 - Let dry at least overnight to ensure that the spot is disinfected.
 - Shampoo carpet, if needed, or use 3% hydrogen peroxide to remove discoloration.
- Procedure for larger spills on carpets:
 - Pour disinfectant on the spot and let stand at least 30 minutes to allow some disinfection to take place. Blot up excess liquid with disposable towels.
 - Soak the area with additional disinfectant. Allow to dry overnight. Shampoo carpet, if needed, or use 3% hydrogen peroxide to remove discoloration.

All contaminated towels and gloves should be double-bagged and labeled with the biohazard symbol.