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LABORATORY SAFETY GUIDE

(UCSI UNIVERSITY)

Document Control

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Responsibility

Policy Owner:	**SCIENCE LABORATORIES**
Managed by:	**QUALITY ASSURANCE AND ENHANCEMENT**

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Summary of the UCSI University Laboratory Safety Guide

1. Personal safety is first. If you have any question look for answers.
2. No food or drink is permitted in the laboratory.
3. Do not smoke in the laboratory.
4. No mouth pipetting.
5. Know the location of emergency exits, eyewash stations, safety showers, fire extinguishers, and first aid kits and how to use them.
6. Laboratory coat should be worn at all times in the laboratory. If your laboratory coat gets contaminated with any chemicals, take it off and wear a clean one. Due to accumulation of chemicals in the laboratory coat material, laboratory coat should be taken off as you leave the laboratory and not be worn outside the laboratory.
7. Shoes that cover the whole feet should be worn at all times in the laboratory. Open toe shoes are not permitted.
8. Eye protection is mandatory at all times when working in the laboratory. Contact lenses are not permitted in the laboratory because they can absorb chemical vapours and trap them against the eyes.
9. Gloves should be used most of the time in the laboratory, especially when handling chemicals.
10. Should you need to work alone in the laboratory after normal hours, you must obtain permission from your supervisor and lab staff.
11. Spills shall be cleaned immediately according to the Material Safety Data Sheet (MSDS) and/or chemical spillage procedures.
12. Read and follow the instructions in the laboratory manual and those given by the lecturer with regard to handling of all materials when conducting an experiment and with regard to disposal of materials used in the laboratory class.
13. Read and follow the operating procedures in the use of laboratory equipment.
14. All cultures, stocks and other biological materials must be autoclaved before disposal according to the ISO procedure.
15. All work surfaces (e.g., benches, laminar flow cabinet, biosafety cabinet, sinks, doors, handles, etc) must be decontaminated with bleach and industrial grade Lysol immediately after any contamination with viable material and upon completion of work.
16. Any time a frozen storage container (freezer, ultra cold, liquid nitrogen) is opened, eye and face protection (cryogenic gloves, face shield or goggles, and a surgical mask) should be worn by persons handling the material.
17. Whenever potentially infected animals or tissues in the laboratory are not contained in a Biosafety Cabinet, all persons must wear face protection for anticipated splashes or sprays of infectious or other hazardous materials.
18. If an equipment is not working it shall be reported immediately to the laboratory staff
19. If glassware has been broken it shall be reported immediately to the laboratory staff so it can be repaired or replaced and the broken pieces properly disposed.
20. It is everyone's responsibility to advise a partner when unsafe behaviours have been practised and report it to the laboratory staff if not rectified immediately.
21. Use safety respiratory equipment and/ or fume hood when handling solvent. Avoid inhaling solvent vapours or chemical dust.
22. Use fume cupboard/hood or personal protection equipment whenever the experimental procedure requires it.
23. Consider all materials in the laboratory as toxic unless otherwise stated.
24. Do not work in the laboratory if you are feeling unwell. Exposure to chemicals when not well may complicate your health condition.
25. No running and horseplay are allowed.
26. Always wash your hands with soap and water before leaving the laboratory.

Declaration of adherence to the UCSI University Laboratory Safety Guide

In respect of further details of laboratory safety, please refer to the **UCSI University Laboratory Safety Guide** (in the UCSIU website)

I, _____ Staff* / Student* ID No: _____ have read and will at all times, observe all the safety guidelines in the Laboratory Safety Guide which is accessible to me in the UCSI University website.

Staff / Student:	HOD/Laboratory Manager (Witness)
Signature :	Signature : .....
Name :	Name : .....
I.D. No. :	Date : .....
Date :	

*Delete accordingly

Last updated on the 20/01/2015-LSGC.

GENERAL LABORATORY SAFETY PRACTICES

The purpose of this guide is to promote safety awareness and encourage safe work practices in the laboratory in line with the Occupational Safety and Health Act and Regulations 1994, Health and Safety Policy (UCSI University) and OHSAS 18001:2007 requirements for which our institution has been certified. These are guidelines; they should serve as a reminder of things you can do to work more safely. Although these guidelines are applicable to all research, teaching and academic laboratories, your lab may require more specialized rules that apply to specific materials and equipment. Please see Laboratory Staff (LS) or Principal Investigator (PI) for more information before beginning work in the laboratory

AWARENESS

- Be alert to unsafe conditions and actions, and call attention to them so that corrections can be made as soon as possible.
- Label all storage areas, refrigerators, etc., appropriately, and keep all chemicals in properly labelled containers as stipulated in *Occupational Safety and Health (Use And Standards Of Exposure Of Chemicals Hazardous To Health) Regulation 20 and 21*.
    - Date all bottles when received and when opened.
    - Note expiration dates on chemicals.
    - Note special storage conditions.
- Be familiar with the appropriate protective measures to take when exposed to the following classes of hazardous materials as stipulated in *Occupational Safety And Health (Classification, Packaging And Labelling Of Hazardous Chemical) Regulation, Schedule 1 Of Regulation 2, Schedule 2 Subregulation 7(1)(C), Schedule 3 Paragraph 7(1)(D), And Schedule 4 Paragraph 7(1)(E)* . Information is available from the LS and MSDS.
    - Flammables
    - Corrosives
    - Toxics
    - Reactives
    - Compressed Gases
    - Biohazards
    - Carcinogens
- Segregate chemicals by compatibility groups for storage.
- Be aware of the potential interactions of lab furniture and equipment with chemicals used or stored in the lab. (e.g., oxidizers should not be stored directly on wooden shelving)
- Post warning signs for unusual hazards such as flammable materials, biohazards or other special problems.
- Pour more concentrated solutions into less concentrated solutions to avoid violent reactions (i.e., always add acid to water; not water to acid).
- Avoid distracting any other laboratory member. Practical jokes or horseplay have no place in the laboratory.
- Use equipment only for its designated purpose.
- Position and secure apparatus used for hazardous reactions in order to permit manipulation without moving the apparatus until the entire reaction is complete.

PERSONAL SAFETY

Respiratory and Body Protection

- Use fume hoods whenever possible.
- Safety goggles should be worn at all times (where applicable) in the laboratory.
- Laboratory coat/apron should be worn in the laboratory.
- Appropriate gloves should be worn as needed.
- Appropriate closed-toed shoes should be worn in the laboratory.
- Respirators may only be worn by individuals that have completed respirator training and fit testing and obtained a respirator medical clearance.

Personal Hygiene

- Wash hands before leaving laboratory.
- Launder clothing worn in laboratory separately from other clothing.
- Never mouth pipette anything in the laboratory
- Never eat, drink or apply cosmetics in a laboratory or areas where chemicals/hazardous agents are stored. (Smoking is prohibited in all areas of University buildings, including laboratories.)
- Never store food in a refrigerator where hazardous materials are stored.
- Never eat or drink from laboratory glassware.
- Avoid wearing contact lenses in the laboratory.
- Avoid situating long hair, loose sleeves/cuffs, rings, bracelets, etc. in close proximity to open flames or operating machinery.
- Keep exposed skin covered. Shorts, sleeveless or short sleeve shirts, skirts or open-toed shoes should not be worn in the laboratory.

FIRE PREVENTION

- Be aware of ignition sources in laboratory area (open flames, heat, electrical equipment).
- Purchase and store flammable reagents in the smallest quantities available.
- Store flammable liquids that require refrigeration in explosion-proof refrigerators.
- Store flammable liquids in appropriate safety cabinets and/or safety cans.
- Do not store incompatible reagents together (e.g., acids with flammables). Lists of incompatible reagents can be found in several source books (for example, Handbook of Reactive Chemical Hazards). See Appendix IV for a table of some commonly-used laboratory chemicals and incompatibilities.
- Do not store ethers or conjugated dienes for extended periods of time as explosive peroxides could form. Date ethers when received and opened.
- Make sure that all electrical cords are in good condition. All electrical outlets should be grounded and should accommodate a 3-pronged plug. Never remove the grounding prong or use an adapter to bypass the grounding on an electrical cord.
- Remain out of the area of a fire or personal injury unless it is your responsibility to meet the emergency responders. Meet responders from a safe location.
- Be aware of the condition of fire extinguishers. Report any broken seals, damage, low gauge pressure or improper mounting to Group Logistics Management. If the seal has been broken, assume that the fire extinguisher has been used and must be recharged. (NOTE: Do not use fire extinguishers unless you are trained and feel confident to do so.) Report ALL fires by phoning **3189** (SW)/**5401** (NW) Security Guard house number. Security guards must have all the relevant emergency contacts.
- Automatic fire sprinklers must remain clear and unblocked to function properly. Do not store materials within 18" below the sprinkler head.

HOUSEKEEPING

- Eliminate safety hazards by maintaining laboratory work areas in a good state of order.
- Maintain at least two clear passages to laboratory exits.
- Always keep tables, fume hoods, floors, aisles and desks clear of unnecessary material.
- Wipe down bench tops and other laboratory surfaces after each use with an appropriate cleaning or disinfecting agent.
- All equipment should be inspected before use.
- Use borosilicate glassware for laboratory work. If dichromate/sulfuric acid glass cleaner is used in your laboratory, make sure that cleaning is confined to the fume hood as toxic chromyl chlorides are released from the dichromate/sulfuric acid solution. Better yet, switch to a non-chromate cleaning solution. (i.e., No Chromix®) which will also minimize hazardous waste generation.

- If experiments must be left unattended, place a note next to experimental apparatus indicating the chemicals involved, your name and a number where you can be reached in case of an emergency.
- Keep the laboratory floor dry at all times. Immediately attend to spills of chemicals or water, and notify other laboratory workers of potential slipping hazards.
- All machinery under repair or adjustment should be properly tagged prior to servicing. All service work should be done by authorized personnel.
- Sink traps and floor drains should be flushed and filled with water on a regular basis to prevent the escape of sewer gases or the release of chemical odors in the event of an emergency. Drains which will not be routinely used may be "topped" with 20 - 30 ml of mineral oil to prevent evaporation of water in the trap.
- All compressed gas cylinders should be securely chained or clamped to a rack or fixed stationary piece of lab furniture. Mark empty cylinders, but use all safety precautions as if the cylinder were full.

EMERGENCY PROCEDURES

- In the event of an emergency (e.g. large chemical spillage, fire, etc), remember numbers: **3189 (SW)/5401 (NW)**. By calling this number, all necessary emergency response departments can then be alerted to your needs.
- Be familiar with the Fire Escape Plan which display the location of emergency exit and the Assembly Point. This escape plan is displayed at each laboratory.
- Be sure the names and phone numbers of lab personnel to be contacted in an emergency are posted in the lab or outside of the door.
- Be familiar with the location, use and limitations of the following safety devices:
  - safety shower
  - eye wash station
  - protective respiratory gear
  - fume hood
  - fire extinguisher
  - fire alarm
  - spill cleanup materials
  - first aid kit
- Clean up all small spills immediately. If a large chemical spill occurs, call the campus emergency phone number: **3189** (SW)/**5401** (NW). If the spill poses a hazard to individuals outside of the laboratory, follow the laboratory's emergency standard operating procedure. Stop current reactions or equipment if possible, activate the building fire alarm, exit the building, call **3189** (SW)/**5401** (NW) to report the emergency and stand by at a safe distance to provide information to emergency response personnel.
- If volatile, flammable, or toxic materials spill, shut off flames and spark-producing equipment at once and evacuate.
- In the event of fire or explosion, activate the building fire alarm, exit the building, call **3189** (SW)/**5401** (NW) to report the emergency and standby at the Assembly Point to meet emergency responders.
- Do not cover windows of laboratory doors, except for special experimental requirements. This allows passers-by to notice if anyone is in need of emergency assistance.
- Maintain a clear path to all safety equipment at all times.

WASTE DISPOSAL

- MINIMIZE WASTES at the source by limiting the quantities of materials purchased and used.
- Segregate and prepare chemical wastes for disposal in accordance with the laboratory procedure
- Dispose of all waste in designated containers. The final disposal of waste shall be handled by certified waste management company.

MISCELLANEOUS

- Children and pets should not be brought into the laboratory.
- If work is being conducted after working hours, let other laboratory personnel know of your presence. If possible, avoid carrying out experiment alone in the laboratory. It is advisable to have someone within calling distance.

SAFETY EQUIPMENT

Laws and regulations make the protection of workers' health and safety a legal requirement as well as an economic necessity. In the final analysis, personal and laboratory safety can be achieved only by informed, responsible individuals. This section summarizes various forms of personal and laboratory safety equipment. Based on this information, knowledgeable choices for appropriate personal protection in the laboratory can be made as stipulated in *Occupational Safety And Health Act, Part 4 Sec. 15, Part 6 Sec. 24 And Occupational Safety And Health (Use And Standard Of Exposure Of Chemical Hazardous To Health) Regulation 16.*

PERSONAL PROTECTIVE EQUIPMENT

Eye Protection

Putting on eyewear is often regarded as a burdensome task, considered as unattractive and restrictive. However, the chemical laboratory is likely to be the most health-threatening place that you can encounter. Splashing chemicals and flying objects are possible at any time in the lab environment. For this reason, eye protection is an important consideration. Protective eyewear for personnel and visitors should be splash proof. If you don't have safety glasses, tell your supervisor. Safety glasses are sold at the campus bookstore in the South Wing Campus, Block A.

Use and Maintenance

- Eye wear should be as comfortable as possible, fit snugly over the eyes and around the face, and not interfere with the movement of the wearer.
- When it is appropriate, signs should be posted outside the door stating that eye protection is required before entering the room.
- Appropriate eye protection should be worn when using:
  - caustics, corrosives, or irritants
  - lasers (special lens protection required)
  - UV light (special lens protection required)
  - cryogenic material
  - glassware under vacuum or pressure (reduced or elevated)
  - flammable materials
  - explosives
  - biohazards
- Eye protection should also be worn when performing these machine shop operations:
  - welding
  - grinding
  - sanding
  - drilling
  - cutting
  - sawing
- Eye safety equipment should be capable of being cleaned and disinfected.
- Eye protection should always be kept in good condition.

Corrective Lenses

- Laboratory workers whose vision requires the use of corrective lenses should wear safety eye protection of one of the following types:
  - Prescription lens safety splash goggles.
  - Splash-proof safety eye wear that can be worn over prescription glasses without disturbing the adjustment of the glasses.

Contact Lenses

- Contact lenses should not be routinely worn in the laboratory. Laboratory personnel who must wear contact lenses while performing laboratory work should be aware of the following potential hazards:
  - It may be impossible to remove contacts from the eyes following entry of some chemicals into the eye area.
  - Contact lenses will interfere with emergency flushing procedures.
  - Contacts may trap solid materials in the eyes.

- Use of contact lenses should be considered carefully, with extra consideration given to choosing eye protection that fits snugly over the eyes and around the face.

Protective Clothing

Lab Coat

- The lab coat is designed to protect the clothing and skin from chemicals that may be spilled or splashed. It should always be properly fitted to the wearer and is best if it is knee length. There are several different types of lab coats for different types of protection.
  - Cotton protects against flying objects, sharp or rough edges and is usually treated with a fire retardant.
  - Wool protects against splashes of molten materials, small quantities of acid, and small flames.
  - Synthetic fibers protect against sparks and infrared or ultraviolet radiation. However, synthetic fiber lab coats can increase the severity of some laboratory hazards. For instance, some solvents may dissolve particular classes of synthetic fibers, thereby diminishing the protective ability of the coat. In addition, on contact with flames, some synthetic fibers will melt. This molten material can cause painful skin burns and release irritating fumes
  - Aluminized and reflective clothing protect against radiant heat.
- The construction of the material must also be considered (twill, felt, plain, etc.), as the materials are rated differently by various manufacturers. Lab coats should be made with snaps/fasteners which afford the wearer quick removal in the event of an emergency.

Aprons

- An apron provides an alternative to the lab coat. It is usually made of plastic or rubber to protect the wearer against corrosive or irritating chemicals. An apron should be worn over garments that cover the arms and body, such as a lab coat.

Hand Protection

It is a good idea to always get into the habit of wearing protective gloves in the laboratory. Aside from acting as a shield between hands and hazardous materials, some gloves can also absorb perspiration or protect the hands from heat. Because certain glove types can dissolve in contact with solvents, it is important to take extra care in matching the protective glove with the nature of the job. Before use, check to make sure the gloves (especially latex gloves) are in good condition and free from holes, punctures, and tears.

Glove Types and Removal

- Gloves should be selected on the basis of the material being handled and the particular hazard involved. Glove manufacturers and the Material Safety Data Sheets (MSDSs) accompanying products in use are good sources of specific glove selection information.
  - PVC protects against mild corrosives and irritants.
  - Latex provides light protection against irritants and limited protection against infectious agents.
  - Natural Rubber protects against mild corrosive material and electric shock.
  - Neoprene for working with solvents, oils, or mild corrosive material.
  - Cotton absorbs perspiration, keeps objects clean, provides some limited fire retardant properties.
  - Zetex® when handling small burning objects. These are a good replacement for asbestos gloves. (**Asbestos containing gloves may not be purchased or used in UCSI University labs since asbestos is a known carcinogen. Asbestos gloves currently located in UCSI University laboratories must be disposed through the university's asbestos waste disposal system. If your laboratory currently has asbestos gloves (or products) for disposal, seal them in a plastic bag, label the contents of the bag and keep in the chemical waste storage cabinets for proper disposal**).

- When working with extremely corrosive material, wear thick gloves. Take extra precaution in checking for holes, punctures, and tears.
- Care should be taken when removing gloves. Peel the glove off the hand, starting at the wrist and working toward the fingers. Keep the working surface of the glove from contacting skin during removal. Contaminated disposable gloves should be discarded in designated containers (e.g., biohazardous waste containers).
- Wash hands as soon as possible after removing protective gloves.

Foot Protection

Foot protection is designed to prevent injury from corrosive chemicals, heavy objects, electrical shock, as well as giving traction on wet floors. If a corrosive chemical or heavy object were to fall on the floor, the most vulnerable portion of the body would be the feet. For this reason, shoes that COMPLETELY COVER AND PROTECT the foot are recommended.

- Fabric shoes, such as tennis shoes, absorb liquids readily. If chemicals happen to spill on fabric shoes, remove footwear immediately.
- When selecting footwear for the lab, choose sturdy shoes that cover the foot. These will provide the best protection.
- The following shoe types should not be worn in the laboratory:
  - sandals
  - clogs
  - high heels
  - shoes that expose the foot IN ANY WAY
- The following are recommended types of footwear:
  - Safety Shoes (steel-toed) protect against crushing injuries caused by impact from any object during work activities (e.g., lifting heavy objects, using power tools, etc.).
  - Treated Shoes, Rubber Boots or Plastic Shoe Covers protect against corrosive chemicals.
  - Insulated Shoes protect against electric shock.
  - Rubber Boots with slip resistant outer soles provide traction in wet conditions where the possibility of slipping exists.
- Safety Shoes, Rubber Boots or Plastic Shoe Covers protect against specific types of chemical contamination and like gloves must be selected to match the current hazard.

Hearing Protection

Ear protection should be worn where the noise level is above 85 decibels (dBA). Areas where excessive noise is present should be posted with signs indicating ear protection is required. Ear protectors should be readily available and rated for sufficient noise reduction.

- Noise reduction ratings (NRR) for hearing protection products must be listed on hearing packaging. The NRR number is used in context of the following formula:
  Noise Dose in dBATWA8-(NRR-7)
  dBA = decibels on an A weighted scale
  TWA8 = eight hour time weighted average
  NRR = noise reduction rating.
- Types of ear protection include:
  - Ear plugs provide basic protection to seal the ear against noise.
  - Ear muffs provide extra protection against noise, and are more comfortable than ear plugs.
  - Cotton inserts are poor suppressors of noise and should be avoided.

Head Protection

Some environments within UCSI University have the potential for falling or flying objects. Appropriate head protection can protect laboratory workers from impacts, penetration by falling or flying objects, electric shock and burns.

- ❖ Unrestrained long hair can be hazardous. The use of caps, elastic bands or hair nets will prevent the hair from coming in contact with instrument/machinery parts, chemicals or flame-producing sources.

Respiratory Protection

Because certain laboratory procedures can produce noxious fumes and contaminants, respiratory protection may be required in your work environment. In fact, lab personnel noting changes in air quality should contact their Lab Manager/Chief Technologist and express their concerns. When engineering controls cannot successfully minimize or eliminate the potentially harmful fumes, a respiratory protection programme should be established. A medical examination is also required to assure the potential respirator wearer is physically capable of respirator use.

Personal Protective Equipment available in UCSI University Laboratories

- ❖ Every laboratory staff is provided with his/her own safety glasses or goggles.
- ❖ A gas mask, a face shield and an apron is available in each lab.
- ❖ Disposable latex gloves and nitrile gloves are available in all labs.
- ❖ Cryogenic gloves are available in labs where liquid nitrogen and -80°C freezer are used.

Laboratory Safety Equipment

- Chemical fume hoods
- Chemical storage cabinets
- Refrigerators
- Eyewash stations
- Safety showers
- Fire safety equipments

Laboratory Equipment

- Glassware
- Heating devices
- Vacuum systems
- Centrifuges
- Cutting equipments

Special classes of materials

- Carcinogens
- Mutagens and teratogens
- Biohazards and infectious waste
- Compressed gases
- Cryogenic materials

Laboratory Safety Equipment

Chemical Fume Hood

Chemical fume hoods capture, contain, and expel emissions generated by hazardous chemicals. Therefore, the fume hood offers an extra measure of protection. If the fume hood in your lab does not appear to be in good working order (a tissue, held inside the fume hood, can indicate if airflow is present), or if you have any questions, inform laboratory staff. (NOTE: Do not allow tissues or other material to be pulled into the hood exhaust system as this may damage the unit or affect the air flow.)

Operation

- All laboratory workers with access to a laboratory chemical fume hood should be familiar with its use.
- Maintain the sash at or below the optimum operating height as designated by the label with an arrow.
- The optimum condition for general laboratory work in a chemical fume hood is between 80 and 125 fpm face velocity in a well installed unit. Higher face velocities often produce turbulence inside of the hood sufficient to eject contaminants into the laboratory.
- Raise large objects that must be in the hood (i.e., a water bath) to allow airflow beneath and on all sides of the object.
- **ALWAYS** work back into the hood, **six inches** beyond the sash line, keeping the sash line between your body and your work.

Maintenance

- The fume hood need to be inspected at an interval not longer than one month and has to be examined and tested by Hygiene Technician at an interval not longer than twelve months as stipulated in *Occupational Safety and Health (Use and Standard Exposure to Chemicals Hazardous to Health) Regulation 17*.
- Keep the inside of the hood clean and uncluttered.
- The hood should always be in good condition and capable of routine use. Any hood or component of ventilation not properly functioning must be taken out of service and clearly tagged.
- The lab worker should not be able to detect strong odors released from materials in the hood. If odors are detected, check to make sure that the ventilation fan is turned on. If the fume hood is malfunctioning, discontinue work and inform laboratory staff.
- An emergency plan should exist in case of hood ventilation malfunction.
- All protective clothing should be worn when working with chemicals in the hood. In addition to gloves, safety glasses, and lab coats, a face shield or explosion shield will provide an extra measure of safety from reactive chemicals.
- Solid objects or materials should not be allowed to enter the exhaust ducts at the rear of the hood, as they can become lodged in the duct or fan.
- **Fume hoods should not be used for long-term chemical storage**.

Chemical Storage Cabinets

Storage of flammables and corrosives in the lab should be limited to as small a quantity as possible.

Use and Maintenance

- Chemicals should **NEVER** be stored in alphabetical order without consideration for chemical compatibilities. This system may contribute to the probability of incompatible materials being stored next to one another (e.g. butadiene next to bromine or chlorine). Incompatible reagents should not be stored next to each other. (See the chemical incompatibility chart in the appendices of this manual.)
- Storage outside of the cabinet should be limited to materials used in the current process.
- The vent cap on chemical storage cabinets should not be removed unless the cabinet is attached to an approved ventilation system.
- If a cabinet is connected to a ventilation system, the connection must either have a thermally actuated damper or sufficient insulation on the vent piping to avoid compromising the fire protection ability of the cabinet.

- Glass containers should be stored on the bottom shelf of storage cabinets.

Types of Cabinets
- Flammable liquid cabinets are designed for storage of flammable or combustible liquids.
- Acid/corrosive cabinets are designed for corrosion resistance.
- Bulk storage cabinets can be used for storage of flammable and corrosive liquids outside the laboratory setting.

Refrigerators

While domestic refrigeration units are appropriate for keeping foods cold, they are not designed to meet the special hazards presented by flammable materials. Therefore, laboratory refrigerators should be carefully selected for specific chemical storage needs. To prevent potential safety hazards, the length of storage of any material should be kept to a minimum. In addition, refrigerators should be periodically inspected.

Use and Maintenance
- Each refrigerator, freezer or other cooling unit should be prominently labeled with appropriate hazard signs to indicate whether it is suitable for storing hazardous chemicals. Label chemical hazard refrigerators with the sign "For Chemical Storage Only. No Food or Drink Allowed."
- The containers placed in the refrigerator should be completely sealed or capped, securely placed, and labeled. Avoid capping materials with aluminum foil, parafilm, corks, and glass stoppers.
- Refrigerators should be frost free to prevent water drainage.

Types of Refrigerators
- Because ignitable vapors can build up in refrigerators, it is important to store flammable and combustible materials in specially-designed units. These refrigerators will have self-contained electrical elements to avoid spark-induced explosions.
- Explosion-proof or intrinsically safe refrigerators are specifically designed for hazardous environments, featuring enclosed motors to eliminate sparking.
- Highly volatile flammable and combustible substances that require refrigeration may be stored **only** in explosion-proof refrigerators especially designed for such use. Such refrigerators require direct wiring to the power source via a metal conduit. The same storage requirements apply to any solution or specimen that may release flammable fumes (e.g., the ether impregnated fur of a dead rat has been known to cause an explosion in a refrigerator).

Eyewash Stations

Eyewash stations provide an effective means of treatment when chemicals come in contact with the eyes. Eyewash stations should be readily available and accessible to all laboratory personnel.
- The eyewash facility should be clearly marked and no more than **100 feet**, or 10 seconds, away from every lab work station. Laboratory workers should be able to locate the nearest eye wash facility with their **eyes closed** (eye injuries may involve temporary blindness).
- An eye injury usually accompanies a skin injury. For this reason, eye wash stations should be located near the safety shower and/or drench hose so that eyes and body can be washed.

Use and Maintenance
- Water/eye solutions should not be directly aimed onto the eyeball, but rather, aimed at the base of the nose. This increases the chance of effectively rinsing the eyes free of chemicals (harsh streams of water may drive particles further into the eyes).
  - Eyelids may have to be **forcibly** opened to attempt eye rinse.
  - Flood eyes and eyelids with water/eye solution for a minimum of 15 minutes.
  - Remove contact lenses as soon as possible to rinse eyes of any harmful chemicals.
  - Eye wash stations should be drained and tested weekly by laboratory personnel.

Types of Eyewash Stations

- *Laboratory Bench sprays* with squeeze handles can be installed through the bench top for instant availability.
- *Swivel Eye Wash* mounts on lab bench or counter top adjacent to a sink. It swivels 90< over the sink for use, or out of the way for storage.
- *Bowl-mounted (pin, push plate or foot pedal activators)* provides continuous water flow through a free-standing plumbed unit. The bowl may be directed to a floor drain or connected directly to a sewer connection for easy testing and use.

Safety Showers

Safety showers provide an effective means of treatment in the event that chemicals are spilled or splashed onto the skin or clothing. Safety shower facilities should be installed wherever corrosive chemicals are used (e.g. acids or alkalis) and must be readily available to all personnel.

Use and Maintenance

- Safety showers should be in a **clearly marked** location. The facility should be no more than 100 feet, or 10 seconds, away from every lab work bench.
- Laboratory workers should be able to locate the shower(s) with their **eyes closed** (emergency situations may leave victims temporarily blind).
- Safety showers are operated by grasping a ring chain or triangular rod.
- The pull mechanism is designed for people of most heights but may require a modification for wheelchair access. It should always be accessible and hang freely.
- Safety showers should supply a continuous stream of water to cover the entire body.
- Individuals should remove contaminated clothing, including shoes and jewelry, while under an operating shower.
- Safety showers should be located AWAY from **electrical panels or outlets**.
- If at all possible, safety shower facilities should be installed near appropriate drainage systems.
- Safety showers should be tested monthly by laboratory personnel.

Types of Safety Showers

- *Floor-Mounted* Emergency Combination eye wash/face and body wash mounts directly to horizontal pipes.
- *Deck-Mounted Drench Hose* is a hand operated unit intended to augment a safety shower for quick spot-washing of injuries.

Fire Safety Equipments

1. *Fire Alarms* are designed so that all endangered laboratory personnel and *Equipment* building occupants are alerted by an audible warning (in many buildings there is also visual warning). Fire alarm systems are **not** monitored at a remote location. Fire alarm activations **must be reported** to Emergency Assistance from a safe location.
    - All employees/students should become familiar with the **EXACT LOCATION** of the **fire alarm pull stations** nearest to their laboratory.
    - Sprinkler systems, smoke detectors and heat detectors may automatically activate the fire alarm. (This **should not** be considered a substitute for manual fire alarm activation.)

2. *Fire Extinguishers* are spaced and located as required by current fire codes and standards. Multipurpose fire extinguishers can be found in hallways and near exits in most laboratories. (Note: Special purpose fire extinguishers are provided where necessary but request should be made to the Group Logistics Management).

- **Only use a fire extinguisher if the fire is very small and you know how to use the extinguisher safely. If you can't put out the fire, leave immediately. Make sure the fire department is called even if you think the fire is out.**
- In laboratories, fire extinguishers should be securely located on the wall near an exit. The lab occupant should be aware of the condition of the fire extinguishers by observing them for broken seals, damages, low gauge pressure, or improper mounting.
- Personal-in-charge should perform **annual maintenance** on all fire extinguishers. The last month and year that maintenance was performed is indicated on a tag or sticker on the extinguisher.
- Occupants of labs should **visually inspect** lab fire extinguishers at least semesterly. Units that are missing, have broken seals, low pressure or visible damage should be reported to laboratory staff immediately for replacement.

3. *Sprinklers* are designed to enhance life safety by controlling a fire until the fire department arrives or, in many cases, completely extinguishes a fire.
   - Sprinklers are automatically activated, and laboratory workers should not attempt to shut off or tamper with the system.
   - Items in the laboratory must be stored at least 18 inches below the sprinklers.
   - Items (e.g., wiring or tubing, etc.) must not hang from the sprinklers or sprinkler pipes.
   - Sprinklers must not be painted or otherwise obstructed.
   - Intense heat should not be used near sprinklers.

Laboratory Equipment Safety

Glassware

Accidents involving glassware are a leading cause of laboratory injuries. These can be avoided by following a few simple procedures. In general, be certain that you have received proper instructions before you use glass equipment designed for specialized tasks that involve unusual risks or potential injury. Listed below are some safety rules.

Use and Maintenance

- Handle and store glassware carefully so as not to damage it or hurt yourself.
- Properly discard or repair damaged items.
- When inserting glass tubing into rubber stoppers, corks or when placing rubber tubing on glass hose connections:
  - Protect hands with a heavy glove or towel
  - Lubricate tubing or stopper with water or glycerol and be sure that the ends of the glass tubing are fire-polished
  - Hold hands close together to limit movement of glass should fracture occur
  - Substitute plastic or metal connections for glass ones whenever possible to decrease the risk of injury
  - Use glassware designed for vacuum work for that purpose
  - When dealing with broken glass
    - Wear hand protection when picking up the pieces
    - Use a broom to sweep small pieces into a dustpan
    - Package it in a rigid container (i.e. corrugated cardboard box) and seal to protect personnel from injury.
- Never attempt glass-blowing operations without proper facilities.

Heating Devices

Electrical devices that supply heat for reactions or separations are commonly used in laboratories. Electrically heated devices include:

- Hotplates;
- Hot-tube furnaces;
- Heating mantles;
- Water baths;
- Oven

Improper use could result in fire or burns to the user.

Use and Maintenance

- If baths are required to be activated when not attended, they should be equipped with timers to turn them on and off at suitable hours and, if possible, a thermostat to turn off power if the unit overheats.
- Flammable or combustible solvents should never be used in a heated bath unless housed in a chemical fume hood.
- Before using any heating device:
  - Check to see if the unit has an automatic shut off in case of overheating;
  - Note the condition of electrical cords and have them replaced as required;
  - Make sure the apparatus has been maintained as required by the manufacturer;
  - Check to see that all heating units in use without automatic shut-off have been turned off before leaving an area for any extended period of time.

Vacuum System

Use and Maintenance

- Every laboratory vacuum pump must have a belt guard in place when it is in operation.
- The service cord and switch, if any, must be free of observable defects.
- Use a trap on the suction line to prevent liquids from being drawn into the pump.
- If vapors are being drawn through the pump, a cold trap (which is a tube that will condense vapors passing through it) should be inserted in the suction line to prevent contamination of the pump oil.
- Place a pan under the pump to catch any oil drips.

Explosion Preventions

In order to prevent explosion

If the pump is used for…	You must…
Vacuum distillation or filtration of organic liquids	Direct the discharge to an operating hood or other exhaust system. Discharge into an enclosed space such as a cabinet can cause explosion.
In an area where flammable gas, vapor, or dust are present.	Ensure that the motor, cord, plug, and all electrical parts are explosion-proof.

Glassware

- Glassware used for vacuum distillations or other uses at reduced pressure must be properly chosen for its ability to withstand the external pressure of the atmosphere.
  - Only round-bottom vessels may be subjected to vacuum unless specially designed, such as Erlenmeyer-type filtration flasks.
  - Each vessel must be carefully inspected for defects such as scratches or cracks.
- All vacuum operations must be carried out behind a table shield or lowered fume hood sash because all vacuum equipment is subject to failure by implosion. (Implosion occurs when atmospheric pressure propels pieces inward creating small fragments which are subsequently propelled outward with considerable force.)
- Dewar vessels have a vacuum between the walls and some types can be dangerous when they fail.
  - Glass types can propel glass into the eyes and should be wrapped from top to bottom with cloth tape such as electrician's friction tape. (Mylar tape can be used if transparency is needed.)
  - Large Dewars encased in metal and stainless steel vacuum containers do not require wrapping.
- Glass desiccators are often subjected to partial vacuum due to cooling of the contents. Due to glass thickness and the relatively flat surface of the top and bottom, the desiccator is under a constant tension. It is strongly recommended that you either:
  - Obtain the available desiccator guard made of perforated metal, or
  - Use a molded plastic desiccator which is spherical and has high tensile strength.

Centrifuges

Use and Maintenance

- Do not attempt to operate a centrifuge until you have received instruction in its specific operation. Read the operation manual, if available, and ask an experienced colleague to demonstrate procedures.
- Individual users are responsible for the condition of the centrifuge machine and rotors during and at the end of procedures. This responsibility includes proper loading, controlling speed to safe levels, safe stopping, removal of materials, and cleanup.
- Ultra centrifuge rotors require special cleaning procedures to prevent scratching of surfaces, which can lead to stress points and possible rotor failure during operation.
- In selecting a centrifuge, carefully consider:
  - Location, type, and use
  - Balance capability each time the centrifuge is used
  - Adequate shielding against accidental "flyaways"
  - Suction cups or heel brakes to prevent "walking"
  - Accessibility of parts, particularly for rotor removal
  - Lid equipped with disconnect switch which shuts off rotor if the lid is opened
  - Safeguard for handling flammables and pathogens. (This may include positive exhaust ventilation, a safe location or sealed cups.)
  - Positive locking of head
  - Electrical grounding
  - Locations where vibration will not cause bottles or equipment to fall off shelves

Potential Problem to Look for

PROBLEM	EFFECT	PRECAUTION AGAINST
Unbalanced load	Damage to seals or other parts	Keep lid closed during operation and shut down and stop the rotor if you observe anything abnormal, such as: • noise • vibration
Broken tubes	Centrifuge contamination and personal injury	When loading the rotor: • examine tubes for signs of stress • discard tubes that look suspicious

Cutting Equipments

Safety and health instructions regarding welding, cutting, or similar flame or spark-producing operations to protect personnel and property against heat, evolved gases and fumes, electrical shock, and radiation. Personnel are required to use approved welding, cutting, and grinding equipment and follow the manufacturer's instructions. Such equipment shall be maintained in safe working order at all times. Personnel shall report any equipment defect or safety hazard to supervisor, and the use of such equipment must be discontinued until it is repaired by qualified personnel.

Use and Maintenance

- Operate the machine only after you have received instruction.
- Remove jewelry, eliminate loose clothing, and confine long hair.
- Make sure all guards are in place and operating correctly.
- Always use proper eye protection, wear the proper attire, and safety gloves when handling the machine.
- Ensure the machine is properly grounded.
- Inspect and replace cables that show any signs of defects.
- Practice caution around compressed gas cylinders. Protect gas cylinders from excessive heat, mechanical shocks and arcs. Ensure cylinder is insulated and fastened so it will not fall. Do not use a compressed gas cylinder that appears to be damaged and/or defective.
- If the material requires coolant, be sure that the system is working and make sure used the correct coolant.
- Switch off the machine when you are not using.
- Clean/clear work area/surfaces of unused tools/materials.

FIRST AID AND EMERGENCY PROCEDURES

The first aid and emergency procedures detailed in this section could be life-saving. Become familiar with the information described below, so that disasters can be speedily contained. In the event of any injury, the laboratory staff should be informed immediately.

It is the responsibility of the injured employee or student to report bodily injury or property damage to UCSI University Campus Security at **3189 (SW)/5401 (NW)** even if a police report is filed. A form called FORM/OH&S-02/02 Incident / Accident Investigation Report need to be filled up to report on the accident occurred. This form can be retrieve in the Public Folder.

Supervisors of injured employees must refer to Group Human Resource Office for Workers Compensation Report of Injury.

FIRST AID

(A) Wounds

(1) Small cuts and scratches
- Direct pressure -- place sterile pad over wound and apply pressure evenly with the opposite hand.
- Elevation -- if direct pressure does not control bleeding, raise the area above the level of the heart.
- Cleanse area with soap and water.

(2) Significant bleeding
- Call Emergency Rescue (999-Public Phone; 112-Cell Phone).
- Direct Pressure -- place sterile pad over wound and apply pressure evenly with the opposite hand.
- Elevation -- if direct pressure does not control bleeding raise the are above the level of the heart.

(B) Thermal Burns

(1) First degree burns (e.g., sunburn or mild steam burn) are characterized by redness or discoloration of the skin, mild swelling and pain.

- First Aid procedures for first degree burns are as follows:
    - Apply cold water applications and/or immerse in cold water for at least 10 minutes.
    - Seek further medical treatment as needed.

(2) Second and third degree burns are characterized by red or mottled skin with blisters (second degree), white or charred skin (third degree).

- First aid procedures for second and third degree burns are as follows:
    - Call Emergency Rescue (999-Public Phone; 112-Cell Phone).
    - Wrap area in clean, dry material.

(C) Chemical Burns

If hazardous chemicals should come into contact with the skin or eyes, follow the first aid procedures below.

(1) Skin

- Remove victim's clothes -- don't let modesty stand in the way.
- Remove victim's shoes -- chemicals may also collect here.
- Rinse the area with large quantities of water for at least 15 minutes (sink, shower, or hose).
- DO NOT apply burn ointments/spray to affected areas.
- Call Emergency Rescue **3189 (SW)/5401 (NW)** (999-Public Phone; 112-Cell Phone) without delay.

(2) Eyes (acid/alkali, e.g., HCl, NaOH)

- Call Emergency Rescue **3189 (SW)/5401 (NW)** without delay.
- Rinse area of eyes, eyelids, and face thoroughly with lukewarm water for at least 15 minutes at the eyewash station.

(D) Ingestion of Chemicals

(1) Call Emergency Rescue **3189 (SW)/5401 (NW)** (999-Public Phone; 112-Cell Phone) IMMEDIATELY.

- If the victim is unconscious, turn their head or entire body onto their left side. Be prepared to start CPR if you are properly trained, but be cautious about exposing yourself to chemical poisoning via mouth-to-mouth resucsitation. If available, use a mouth-to-mask resucsitator.

(E) Inhalation of Chemicals

- Evacuate the area and move the victim into fresh air.
    - Call Emergency Rescue **3189 (SW)/5401 (NW)** (999-Public Phone; 112-Cell Phone) without delay.
    - If the victim is not breathing and you are properly trained, perform CPR until the rescue squad arrives. Be careful to avoid exposure to chemical poisoning via mouth-to-mouth resucsutation. Use a mouth-to-mask resuscitator.

- Treat for chemical burns of the eyes and skin as noted above.

FIRST AID KITS

First aid kits should be standard equipment in every laboratory. Commercial, cabinet-type, or unit-type first aid kits are acceptable. A typical first aid kit for laboratories includes a variety of items specially selected to carry out emergency treatment of cuts, burns, eye injuries, or sudden illness. The first aid kit should contain individually sealed packages for each type of item. Contents of the kit should be checked semesterly to ensure that expended items are replaced. Laboratory supervisors are responsible for maintaining the contents of the first aid kit. Kits are available from most general safety or lab supply houses.

No oral medication (including aspirin) should be dispensed from the first aid kit.

EMERGENCY PROCEDURES

NOTE: In the event of an emergency (police, fire, medical, or hazardous materials), refer to dial the campus emergency phone extension **3189 (SW)/5401 (NW)** for 24-hour emergency services. UCSI Security personnel are the most accessible and well equipped for immediate response to emergencies. They are also in direct communication to local Fire Departments and Police authorities

Chemical Spills

- General Safety Guidelines. The procedures described below are to be used for small chemical spills where materials for clean-up are available in the lab and if employees have received training in their use. For larger spills call the campus emergency phone extension at **3189 (SW)/5401 (NW).** When unsure of how to clean up small amounts of a material, notify your supervisor.
  - Locate spill cleanup materials. Laboratories should be equipped with spill cleanup kits. If your laboratory area does not have such emergency items, inform your Lab Manager/Chief to acquire spill cleanup kits.
  - Wear the appropriate personal protective equipment (e.g., gloves, goggles) when cleaning up spills.

- Acid Spills
  - Apply neutralizer (or sodium bicarbonate) to perimeter of spill.
  - Mix thoroughly until fizzing and evolution of gas ceases.
    NOTE: It may be necessary to add water to the mixture to complete the reaction. Neutralizer has a tendency to absorb acid before fully neutralizing it.
  - Check mixture with pH indicator paper to assure that the acid has been neutralized.
  - Transfer the mixture to a plastic bag, tie shut, fill out a waste label, and place in the fume hood. Notify laboratory staff for disposal.

- Caustic Spills
  - Apply neutralizer to perimeter of spill.
  - Mix thoroughly until fizzing and evolution of gas ceases.
  - Check mixture with pH indicator paper to assure that the material has been completely neutralized.
  - Transfer the mixture to a plastic bag, tie shut, fill out a waste label, and place in the fume hood. Notify laboratory staff for disposal.

- Solvent Spills
  - Apply activated charcoal to the perimeter of the spill.
  - Mix thoroughly until material is dry and no evidence of liquid solvent remains.
  - Transfer absorbed solvent to a plastic bag (if compatible), tie shut, fill out and attach a waste label, and place in the fume hood. Notify laboratory staff for disposal.

- Mercury Spills
    - Using a mercury vacuum, vacuum all areas where mercury was spilled with particular attention to corners, cracks, depressions and creases in flooring or table tops.
    - Store recovered mercury in the chemical waste cabinets for disposal.
    - To clean up small spills with a mercury spill kit, dampen the mercury sponge with water, then wipe the contaminated area.
    - Do this procedure slowly to allow for complete absorption of all free mercury. A silvery surface will form on the sponge.
    - Place the contaminated sponge in its plastic bag, tie shut, fill out and attach a waste label, and place in the fume hood. Notify laboratory staff for disposal.
    - For larger spills that cannot be cleaned up by lab occupants, call the campus emergency number: **3189** (SW)/**5401** (NW).

Biohazard Spills

- Appropriate personal protective measures must be taken for cleanup of potentially-infectious wastes. Laboratories using infectious agents should be certified at the appropriate biosafety. Procedures for containing and cleaning up spills of infectious agents will be reviewed and level approved by the Biological Safety Officer as part of the certification process.

Fire Safety

- Laboratory staff must be knowledgeable of the UCSI University Campus Emergency Guide. This official document is located in our website. It describes the procedures occupants must take in the event of fire or other emergencies.
- Laboratory supervisor should develop a plan which incorporates specific instructions relating to their laboratories into the UCSI University Emergency Guide. Specific instructions should include:
    - Location of exits and emergency escape routes.
    - Locations of fire alarm pull stations and emergency phones.
    - Operations to be shut down, turned off or secured before evacuation **without placing personnel in danger**.
    - A location for laboratory personnel to meet and the procedure to account for personnel after an evacuation.
    - Laboratory supervisors should review the plan with new employees and students and annually with all personnel.
- The laboratory-specific fire escape plan should be posted in the laboratory.

Small Laboratory Fires

- Small fires which are **contained in beakers or flasks** can be extinguished by covering the fire with a larger beaker if the laboratory personnel are confident to do so.
    - **DO NOT attempt to fight a fire that cannot be extinguished immediately by covering with a larger beaker. Initiate the fire emergency procedures located in Section 5 of the UCSI University Campus Emergency Guide. (See Appendix V)**

- The rescuer should instruct the victim to **STOP - DROP - ROLL.** Victims should also place their hands over their face.
- The victim should **NOT** run to a fire blanket. If a fire blanket is available, it may be used by a rescuer to smother the flames.
- **DO NOT** use fire extinguishers to extinguish a person that is on fire.
- **DO NOT** attempt to remove clothing from burned areas.

- ❖ **Call for emergency assistance 3189** (SW)/**5401** (NW) **immediately.**
- ❖ **DO NOT** put water on large burns.
- ❖ Keep burned areas clean and dry.
- ❖ Keep victim calm.
- ❖ For information or questions on fire emergency procedures, call **3189** (SW)/**5401** (NW) or Balai Bomba Dan Penyelamat Taman Segar, Cheras (Fire Department and Rescue Services): **03-9132 9490**

PROPERTIES OF HAZARDOUS CHEMICALS

(A) FLAMMABILITY

Flammability is a measure of how easily a gas, liquid, or solid will ignite and how quickly the flame, once started, will spread. The more readily ignition occurs, the more flammable the material. Flammable liquids themselves are not flammable; rather, the vapor from the liquids is combustible. There are two physical properties of a material which indicate its flammability: flash point and volatility (boiling point).

The flash point of a material is the temperature at which a liquid (or volatile solid) gives off vapor in quantities significant enough to form an ignitable mixture with air. Given an external source of ignition (i.e., spark, flame), a material can ignite at temperatures at or above its flash point. The flash point of ethyl ether, a highly flammable solvent, is –40°C. Kerosene has a flash point between 65°C and 85°C. Flammable gases have no flash point, since they are already in an ignitable form.

The volatility of a material is an indication of how easily the liquid or solid will pass into the vapor stage. Volatility is measured by the **boiling point** of the material -- the temperature at which the vapor pressure of the material is equal to the atmospheric pressure. The term volatility is often mistakenly used as a synonym for flammability. There are some materials that are volatile but not flammable such as water, chloroform and mercury.

Some materials are pyrophoric, meaning that they can ignite spontaneously with no external source of ignition. Potassium metal, for example, can react with the moisture in air. This reaction causes hydrogen gas to be evolved, and the heat generated by the reaction can be hot enough to ignite the hydrogen.

- Examples of commonly-used flammable chemicals.
  - Acetone
  - Sodium
  - Lithium
  - Ethyl alcohol
  - ethyl ether
  - hydrogen
  - acetylene
  - potassium

Labeling & Information:

- Each container of flammable liquid should be properly labeled before use.
- Product flammability may be indicated on the label by a picture of a flame, a flame in a red diamond, a numeric code in a NFPA Hazard Rating system diamond or by the words flammable or combustible.
- Flammability information can be found on the MSDS under **Fire and Explosion Data**. Flash point and boiling point information can be found in the section entitled **Physical Properties**.

Storage:

- Flammable materials should never be stored near acids or oxidizers.
- Keep storage areas cool to decrease the possibility of formation of vapors in excess of the lower flammable limit for the material or autoignition in the event that vapors mix with air. Adequate ventilation should be provided to prevent vapor build-up under normal storage conditions.
- Do not store flammable materials in conventional (non-explosion proof) refrigerators. Sparks generated by internal lights or thermostats may ignite flammable material inside the refrigerator, causing an extremely dangerous explosion hazard.
- Storage areas should have spill cleanup materials and an emergency plan nearby, including the location of the nearest fire alarm pull station. Do not attempt to extinguish a fire in a flammables storage area.
- Storage areas should be inspected periodically for deficiencies, and storage of flammable materials should be kept to a minimum.
- "**NO SMOKING**" and **"INFLAMMABLE MATERIAL"** signs should be clearly posted where flammable materials are stored.

Handling:

- Use gloves and splash-proof safety goggles when handling flammable liquids.
- Mixtures of flammable or combustible liquids should be treated as though the mixture had the lowest flash point represented.
- Dispensing of flammable or combustible liquids should only be carried out under a fume hood or in an approved storage room.
- When transferring or using a flammable liquid, all ignition sources should be eliminated from the area. **Open flames or hot plates should NOT be used to directly heat flammable liquids**.
- **DO NOT** use water to clean up flammable liquid spills.
- **DO NOT** dispose of flammable or combustible liquids in the sink or drain.
- All laboratory waste should be properly labeled and store in the waste storage cabinets provided for collection by the waste disposal company.

(B) CORROSIVITY

- Gases, liquids, and solids can exhibit the hazardous property of corrosivity. Corrosive materials can burn, irritate, or destructively attack skin. When inhaled or ingested, lung and stomach tissue are affected. Corrosive gases are readily absorbed into the body through skin contact and inhalation. Corrosive liquids are frequently used in the laboratory and have a high potential to cause external injury to the body. Corrosive solids often cause delayed injury.
- Because corrosive solids dissolve rapidly in moisture on the skin and in the respiratory system, the effects of corrosive solids depend largely on the duration of contact.
    - Materials with corrosive properties can be either **acidic** (low pH) or **basic** (high pH). Examples of corrosives are listed below:

        - sulfuric acid
        - nitric acid
        - sodium hydroxide
        - hydrochloric acid
        - ammonium hydroxide
        - chromium trioxide

Labeling & Information:

- The corrosive label normally depicts the corrosion of a hand and bar of steel.
- Information on corrosivity can be found in the Material Safety Data Sheet (MSDS) under **Health Effects and First Aid**.

Storage:

- Segregate acids from bases, and corrosive materials from both organic and flammable materials.
- Store corrosive materials near the floor to minimize the danger of falling from shelves.
- Store in cool, dry, well-ventilated areas and away from sunlight. The storage area should not be subject to rapid temperature changes.

Handling:

- Wear adequate protective equipment (lab apron, appropriate gloves and splash-proof eye protection). If splashing is a definite hazard, face shields must also be worn.
- Corrosive materials should be handled in a fume hood to protect the user from the possible generation of hazardous or noxious fumes.
- Add reagents slowly. Always add acids to water (never water to acid). During the addition of reagents, allow acid to run down the side of the container and mix slowly.
- Corrosive materials should be transported in unbreakable containers.
- For cleaning corrosive spills, refer to Emergency Procedures.

(C) REACTIVITY

Explosives:

- Explosive materials are chemicals that cause a sudden, almost instantaneous release of large or small amounts of pressure, gas and heat when subjected to sudden shock, pressure or high temperature.
- Some substances, under certain conditions of shock, temperature or chemical reaction, can explode violently. Such explosions present many hazards to laboratory personnel.
    - flying glass can seriously lacerate skin
    - fires can result from burning gases
    - corrosive or toxic substances can be liberated

- Before working with explosive materials, understand their chemical properties, know the products of side reactions, the incompatibility of certain chemicals, and monitor possible environmental catalysts (such as temperature changes).
- Examples of materials that may be explosive under some conditions of use:
    - acetylene
    - azide
    - hydrogen
    - nitro compounds
    - ammonia
    - organic peroxides
    - perchlorates
    - bromates

Labeling & Information:

- Information on explosives can be found on the Material Safety Data Sheet (MSDS) under **Fire and Explosion Data**.

Storage & Handling:

- Explosion hazards. AVOID:
    - allowing picric acid to dry out
    - mixing flammable chemicals with oxidants
    - flammable gas leaks
    - heating compressed or liquified gas
    - uncontrollable or fluctuating temperatures during experiments using explosive chemicals
    - bringing hot liquid (e.g., oil) into sudden contact with a material possessing a lower boiling point
    - contacting flammable materials with catalysts (e.g., acids or bases catalyze an explosive polymerization of acrolein)
    - explosive peroxide generation products that build up in solvent containers during storage
    - mixing nitric acid with acetone
    - distilling ethers unless free from peroxides

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- Carefully plan a procedure for working with explosive materials.
    - Insert experimental apparatus into a dry glove box or gas blanket.
    - Minimize storage of ethers.
    - Keep specified fire extinguishing equipment near the explosive chemical work space.
    - Determine all explosive hazards prior to experimental work, including the stability of reactants/products.

Oxidizers:

- An oxidizing agent is a chemical used to provide oxygen for chemical reactions. Oxidizers spontaneously evolve oxygen at room or slightly elevated temperatures, and can explode violently when shocked or heated. Because they possess varying degrees of chemical instability, oxidizing agents are explosively unpredictable and, therefore, represent a particularly hazardous safety threat.

- Examples of oxidizing agents:
    - peroxides
    - hyperperoxides
    - peroxyesters

- Oxidizers can react violently when in contact with organics. For this reason, avoid interactions between oxidizers and organic materials. Examples of organic-reactive oxidizers include nitric acid, chromic acid, and permanganates.

Peroxides:

- Some organic compounds, such as ethers, can react with oxygen from the air, forming unstable peroxides. Peroxide formation can occur under conditions of normal storage, when compounds become concentrated by evaporation, or when mixed with other compounds. The accumulated peroxides can then violently explode when exposed to shock, friction, or heat. Pure compounds will accumulate peroxides more readily than compounds containing impurities.

- Examples of organic compounds that form hazardous peroxides:
    - aldehydes, ketones
    - ethers
    - compounds with allylene ($CH_2 = CHCH_2R$) structure
    - alkali metals, alkoxides, amines
    - vinyl and vinylidene compounds
    - compounds with benzylic hydrogen atoms

- Examples of chemicals which form hazardous peroxides during exposure to air:

< ethyl vinyl ether	< p-Dioxane
< decalin	< ethyl ether
< tetralin	< isopropyl ether
< tetrahydrofuran (THF)	

- Destruction of the listed chemicals is recommended within 1 year of chemical receipt or 1 month after opening without any testing for peroxide content:

<Acetal	<Diethyl ether
<Allyl ether	<Diethyl fumarate
<Allyl phenyl ether	<Dioxane
<Isoamyl benzyl ether	<1,3-Dioxepane
<Benzyl n-butyl ether	<1,2-Epoxy-3-
<Dibenzyl ether	<isopropoxypropane
<Benzyl ethyl ether	<Isophorone
<Benzyl 1-naphthyl ether	<Dimethoxymethane
<*p*-Dibenzyloxybenzene	<2,2-Dimethoxypropane
<1,2-Dibenzyloxyethane	<1,3,3-Trimethoxypropene
<Chloroacetaldehydediethylacetal	<Di-n-propoxymethane
<2-Chlorobutadiene	<beta-Isopropoxyproprionitrile
<Cyclohexene	<Diisopropyl ether
<Cyclooctene	<n-Propyl isopropyl ether
<Decalin	<Tetralin
<Diethoxymethane	<Vinylidene chloride

- Discard opened containers of peroxidizable compounds not listed above within 12 months or minimum expiration date provided by the manufacturer if less than 12 months.
- Peroxide testing kit should be made available if the laboratory has peroxidizable compounds.

Labeling & Information:

- A pictorial oxidizer label depicts a flaming letter "O" on a yellow background.
- Information on oxidizing agents can be found on the MSDS under the heading **Reactivity Data**.

Storage & Handling:

- Order ether in small quantities and use quickly.
- Include the date of purchase on containers of peroxidizable compounds. Note the date of opening on the label.
- When possible, store peroxidizable compounds (except certain inhibited vinyl monomers) under a nitrogen atmosphere. Keep away from heat, light, and ignition sources.

- Store in a cool, dry, well-ventilated area, out of direct sunlight. Protect from extreme temperatures and rapid temperature changes. DO NOT SMOKE near oxidizers.
- Store in amber glass or inert containers, preferably unbreakable. Containers should be tightly sealed. DO NOT use corks or rubber stoppers to cap containers.
- Before opening glass bottles, look for the presence of solids (crystals) or viscous liquid at the bottom of the bottle. These are good indicators of peroxide formation. Do not open a container that is suspect – send for disposal.
- Isolate reactive chemicals from incompatible materials.
    - organic materials
    - flammable solvents
    - corrosives (i.e., nitric, chromic acids)
- Avoid friction, grinding and all forms of impact while working with oxidizers.
- Avoid mixing oxidizing agents with other chemicals during disposal procedures.
- To detect the presence of peroxides, the following procedure can be used. In a 25ml glass-stoppered cylinder (colorless, protected from the light), add 1 ml of freshly prepared 10% aqueous potassium iodide solution to 10 ml of organic solvent. View the cylinder transversely against a white background. If a yellow or brown color appears, peroxide is present. Send for disposal.

(D) TOXICITY

- The concept of toxicity is unique because it can be applicable to all chemical substances used in the laboratory. The terminology explained below can assist laboratory workers in assessing the degree of hazard and provide guidance in the selection of appropriate personal protective equipment.

- **Toxicity** is defined as the ability of a substance to cause: damage to living tissue, impairment of the central nervous system, severe illness, or in extreme cases, death when ingested, inhaled, or absorbed through the skin.

    - The administration of a particular dosage of a chemical, and the subsequent response by experimental animals, can help predict that chemical's toxic effect on humans. The dose-response behavior is represented by a dose-response curve, which demonstrates that not all individuals will respond to a particular dose of a chemical in the same manner. Some people will be more sensitive than others, and a specific dosage that may be lethal to one person may not be lethal to another.

    - The point on the curve where 50% of the test animals have died as a result of a particular chemical dosage is referred to as the Lethal Dose 50, or **LD_{50}**. The LD_{50} is usually indicated in terms of milligrams of substance **ingested** per kilogram of body weight (mg/kg). The lower the LD_{50}, the more toxic the material.

- The toxicity of a substance via **skin absorption** can be determined several ways. Often, the threshold limit values of a substance will have a "skin" notation, indicating they are rapidly absorbed through the skin. Absorption can also be indicated by the solubility of the material in water. Materials that are extremely soluble in water can dissolve in skin moisture and be transported through the skin's surface. For instance, dimethyl sulfoxide (DMSO) rapidly absorbs into the skin. If any toxic materials are present in this solvent or on the surface of the skin, DMSO will transport these contaminants into the body as well.

- A substance can have either **acute** or **chronic** toxicity. A substance that is acutely toxic will have immediate effects on the health of an over-exposed individual, (e.g., phosgene causes immediate throat irritation at a concentration of 3 ppm and immediate death at 50 ppm). A substance that has chronic toxicity will eventually affect the health of a person due to long-term exposure to that material (e.g., phosgene in concentrations less than 1 ppm over a long period of time are a potential trigger for emphysema).

(E) Poisons

- A poisonous compound is a substance that causes death or serious injury if relatively small amounts are inhaled, ingested or has contacted the skin. All substances can be in some quantity or condition of use.

Labeling & Information:

- Any substance that carries the international poison symbol (skull and crossbones) should be treated as hazardous.
- Information on the poisonous nature of chemicals can be found in the MSDS section **Health Hazard Data**.

Storage & Handling:

- Treat poisonous compounds with extreme caution. Wear protective lab coats, gloves and safety glasses, and work in a functioning fume hood.

Special Classes of Materials

Carcinogens

Carcinogens are substances that will cause cancer in humans or animals given appropriate exposures. Suspect carcinogens are substances that have chemical similarities with known carcinogens or have shown preliminary evidence of carcinogenic activity. Carcinogens can represent an insidious hazard in the laboratory since they can cause disease with exposures that do not produce acute toxic effects. There may be a long latency period between exposure and the appearance of cancer.

The consequence of exposure to carcinogens varies according to the species, the physiological and metabolic state of the organism, and the dosage of the carcinogen (including duration and route of exposure, concurrent exposure to other agents, and other factors). There is continuing scientific debate regarding the minimum exposure required to produce cancer, as well as the relevance of experimentally-induced animal cancers to a human situation. The complex interaction of such determinants makes risk assessment of human exposure to carcinogens exceedingly difficult. Due to these uncertainties, assurance of laboratory safety requires strict limitation of human exposure to carcinogenic substances.

Some compounds are carcinogenic only in combination with certain other compounds. It is known that particular chemicals promote the carcinogenic action of others. Since the potential for synergistic action of most chemicals is unknown, it is essential that caution be exercised with all organic compounds and metals when used in combination with carcinogens.

Labeling and Information

- The following terms, defined by the International Agency for Research on Cancer (IARC), are used to describe material carcinogenicity:
  - Sufficient positive: Those chemicals that were found to promote and increase incidence of malignant tumors in multiple species or strains of lab animals.

- Limited positive: Those chemicals found to promote either malignant tumors in a single strain, or benign tumors in single or multiple species or strains.
- Inadequate: Insufficient evidence to make a decision.
- Equivocal: Almost no supporting evidence.
- Negative: Limited or sufficient significant negative evidence.

- Examples of known or suspected carcinogens are listed below. The risk factor associated with these compounds is high, and alternative compounds should be used whenever possible.
  - 4-Nitrobiphenyl
  - α- and ß-Naphthylamine
  - Methylchloromethyl ether
  - 3,3'-Dichlorobenzidine
  - bis(chloromethyl) ether
  - Chloroform
  - Benzidine
  - 4-Aminodiphenyl
  - Ethyleneimine
  - ß-Propiolactone
  - Benzene
  - Dimethylaminoazobenzene
  - Vinyl chloride
  - 1,2-dibromo-3-chloropropane
  - Arsenic
  - Acrylonitrile
  - N-Nitrosodimethylamine
  - Formaldehyde

- The Occupational Safety and Health Administration (OSHA) regulate the carcinogens listed below:
  - 2-Acetylaminofluorene
  - 4-Dimethylaminoazobenzene
  - Acrylonitrile
  - Ethylenimine
  - 4-Aminodiphenyl
  - Inorganic arsenic
  - Asbestos
  - 4,4'-Methylene bis(2-chloroaniline)
  - Benzene
  - Methyl chloromethyl ether
  - Benizidine
  - alpha-Naphthylamine
  - bis-Chloromethyl ether
  - beta-Naphthylamine
  - Coke oven emissions
  - 4-Nitrobiphenyl
  - 1,2-dibromo-3-chloropropane
  - n-Nitrosodimethylamine
  - 3,3'-Dichlorobenzidine (and its salts)
  - beta-Propiolactone
  - Vinyl chloride

Access and Control

- Entrances into areas where known carcinogens are used should be posted appropriately, such as: "Cancer Suspect Agent, Authorized Personnel Only".
- Laboratory Supervisors/Principal Investigators are required to designate locations within the lab for use of carcinogens. The designation must include consideration of necessary control measures.
- Allow only authorized persons in the laboratory. Close all doors and restrict traffic in the work area when the carcinogen is being used.
- Place warning labels such as "Carcinogen" or "Cancer Suspect Agent" on all stock, dilution, and hazardous waste disposal containers.
- Visitors should be notified about carcinogen use in the laboratory work area.
- Housekeeping personnel must be informed of any possible hazards or special cleaning procedures that are required.
- All work with carcinogens should stop and the area and equipment decontaminated before Physical Plant personnel are permitted to repair or work on equipment, drains, or ventilation ducts.

Personnel Protection

- In some high-risk operations involving carcinogens, a clean room or vestibule may need to be and shower constructed and properly used when entering and exiting a work area.
- Wear protective clothing, preferably disposable, such as gloves, lab coats and respirators when handling carcinogens. Do not wear them outside of the laboratory.
- Under normal working conditions, no carcinogen should contact gloves or clothing. They are the last line of defense.

- Check the manufacturer's description to be sure that the type of glove or respirator planned to be worn truly forms a barrier against the carcinogen being used. This is particularly true when using organic solvents, acids and bases.
- Use mechanical pipettes only.
- There should be no eating, drinking, smoking or other unnecessary hand-to-mouth contact.
- Only small amounts of carcinogens should be kept in stock. Only minimal amounts should be kept at work stations.
- Wash hands with soap after procedures involving a carcinogen.

Storage and Handling

- Containers of carcinogens should be clearly labeled and kept in a separate (preferably locked) storage location. Designated work areas appropriate for carcinogen use should be clearly demarcated.
- Conduct work practices involving volatiles, aerosols or dust in a chemical fume hood exhausted to the exterior so that the possibility of entry into the supply air intake of any building is minimized.
- Check fume hoods, biological safety cabinets (laminar flow hoods) and glove boxes for leaks, air-flow rate and air-flow patterns prior to using them. Follow-up with periodic checks.
- All work surfaces on which carcinogens are used should be stainless steel or covered with plastic trays or dry absorbent plastic-backed paper.
- Laboratory supervisors are responsible for training laboratory workers on proper carcinogen-handling techniques.
- Each laboratory worker must adhere to proper operations, emergency procedures, monitoring of lab work and required medical examinations. Medical records must be accurately maintained when working with carcinogens.
- Before working with suspected or known carcinogenic compounds, obtain health hazard information for each compound. In addition, compile spill cleanup emergency procedures for your laboratory.

Mutagens and Tetratogens

Mutagens

Mutagens are chemical and physical agents that induce mutations in DNA and in living cells. This affects the genetic system in such a way as to cause cancer or hereditary changes in chromosomes. Individuals exposed to chemicals with mutagenic properties may develop genetic damage to the extent that future offspring may be affected.

  - Two forms of somatic (body/organ) cell interference may be noted.
  - Leukemias: White blood cells are produced far more rapidly than they can be removed from the blood, interfering with normal body functions.
  - Cancers: Cells that do not normally divide during adult life begin to proliferate to the extent that such division displaces or invades normal tissues.
- Examples of mutagens:
  - Arsenic
  - Ethidium Bromide
  - Ionizing Radiation (gamma, x-rays)
  - Alkylating agents (i.e., dimethyl sulfate)

Teratogens

Teratogens are chemical and physical agents that interfere with normal embryonic development. Teratogens differ from mutagens in that there must be a developing fetus. Damage to the fetus (embryo) is most likely to occur early in pregnancy, during the first 8 - 10 weeks. Teratogens may produce congenital malformations or death of the fetus without inducing damage to the pregnant woman.

- In general, carcinogenic chemicals should be considered as a hazard to reproductive health. Even though OSHA has established exposure limits for dangerous materials, a developing fetus may be adversely affected by lower doses than those considered acceptable for adult exposure. Toxicology is still not well developed to evaluate reproductive health hazards. However, as of 1985, OSHA has identified three substances as teratogens:
  - Dibromochloropropane
  - Lead
  - Ethylene oxide
- Examples of several other materials that are thought to be associated with reproductive health disorders are listed below.

  - Antimony
  - Carbon disulfide
  - Ethylene thiourea
  - Polychlorinated biphenols (PCBs)
  - Nitrous oxide
  - Formaldehyde
  - Ethylene dibromide
  - Ionizing radiation

Handling and Storage

- See precautions as listed under carcinogens.
- Before working with suspected or known mutagenic or teratogenic compounds, obtain health hazard information for each compound. In addition, compile spill cleanup emergency procedures for your laboratory.
- Exercise extreme caution, as you would with carcinogens. Wear personal protective clothing and equipment, and work in a well ventilated area.

Biohazards and Infectious Waste

Biohazards

- The laboratory supervisor is responsible for the safety of laboratory workers in their area. In handling biohazardous materials, the supervisor should consider:
  - Education/training provisions to introduce laboratory workers to biohazard use and disposal.
  - Access to these areas should be limited to authorized personnel only.
  - The concept of "universal precautions" must be observed when infectious materials or by-products are present.
  - It is the responsibility of the laboratory supervisor to post the international biohazard symbol on all entrances to biohazard work areas along with pertinent emergency information.

Biological, Pathological and Medical Waste

- Biological, Pathological or Medical Waste (BPMW) includes but is not limited to the following wastes:
  - Cultures and stock of infectious agents and associated biological including culture from medical, pathological, research and teaching laboratories; wastes from the production of biologicals; discarded live and attenuated vaccines; and culture dishes and devices used to transfer, inoculate and mix cultures.
  - Blood and blood products. Wastes consisting of human blood, human blood products (includes serum, plasma, etc.) and items contaminated by free-flowing human blood are BPMW.
  - Pathological wastes. All pathological wastes and all wastes that are human tissues, organs, body parts, or body fluids that are removed during surgery, autopsy or other teaching or research procedures, and specimens of the above including their containers are BPMW.
  - Sharps. Used or unused hypodermic needles, syringes, scalpel blades, pasteur pipettes, transfer pipettes, transfer pipette tips, scalpel blades, razor blades, blood vials, needles attached to tubing, needles used with sutures, culture dishes regardless of presence or absence of infectious materials, broken glass and similar devices likely to be contaminated with organisms that are pathogenic to healthy humans and all sharps used in patient care are BPMW.

- Animal wastes. All animal carcasses, body parts, potentially contaminated bedding, and related wastes are BPMW. (When animals are intentionally infected with organisms likely to be pathogenic to healthy humans for the purposes of research, in vivo testing, production of biological materials or any other reason; the animal carcasses, body parts, bedding material and all other potentially contaminated wastes must be treated as BPMW for storage and disposal.)
- Any residue or contaminated soil, water, or other debris resulting from the cleanup of a spill of any BPMW.
- Isolation wastes. Biological wastes and discarded materials contaminated with blood, excretions, exudates, or secretions of humans or animals who are isolated to protect others from highly communicable diseases, or isolated animals infected with highly communicable diseases.
- Any waste contaminated by or mixed with BPMW.

- All biological materials, including recombinant DNA, should be autoclaved prior to discarding.

Decontamination of Materials

- Materials known or suspected to be contaminated with an infectious agent must be sterilized by the generator. In general, autoclaving is the most effective and convenient form of sterilization.

Wet Heat (Steam)

- Also known as autoclaving, this method requires a chamber temperature of at least 250°F(121°C). The processing time begins when the materials being sterilized reach the predetermined temperature. Monitor steam sterilization effectiveness with a biological indicator.

Disinfectants

- The following table lists a description of commonly used disinfectants:

Substance	Description
Alcohols	Ethyl or isopropyl alcohols at 70-80% concentration are good general purpose disinfectants; not effective against bacterial spores.
Quaternary Ammonium Compounds	Cationic detergents are strongly surface-active and extremely effective against lipoviruses; not effective against gram negative bacterial organisms and may be neutralized by anionic detergents (soaps).
Chlorine	Low concentrations (50-500 ppm) are effective against vegetative bacteria and most viruses; higher concentrations (2500 ppm) are required for bacterial spores; corrosive to metal surfaces; must be prepared fresh; laundry bleach (5.25% chlorine) may be used as a disinfectant.
Iodine	Recommended for general use; effective against vegetative bacteria and viruses; poor activity against bacterial spores. Betadine is a good disinfectant for washing hands.

Compressed Gases

The purpose of this section is to assist the laboratory worker with identification, storage, maintenance and handling of compressed gases. Compressed gases can be hazardous because each cylinder contains large amounts of energy and may have high flammability and toxicity potential.

Labeling and Information

- Compressed gas containers may be labeled in five ways:
- Flammable gases are designated by a flame on a red label;
- Non-flammable gas labels depict a gas canister on a green background
- Poison gas labels depict skull and crossbones
- Oxygen-containing gases are designated by the letter "O"
- Chlorine gas is distinctly labeled.
- Know the contents of the cylinder and be familiar with the properties of the gas.

- The contents of the cylinder or compressed gas should be clearly marked and identified with proper labels or tags on the shoulder of the cylinder. **Those cylinders or compressed gases that do not comply with identification requirements should be returned to the manufacturer**.
- If two labels are associated with one cylinder, affix the labels 180 degrees apart on the shoulder of each cylinder. Label all empty cylinders "EMPTY" or "MT" and date the tag. Treat an empty cylinder in the same manner that you would if it were full.

Storage and Handling

- All cylinders should be stored in cool, dry, well-ventilated surroundings and away from all flammable substances including oil, greases, and gasoline. **DO NOT** subjects any part of a cylinder to a temperature higher than 125°F.
- Cylinders should not be located where objects may strike or fall on them.
- Cylinders should not be stored in damp areas, or near salt, corrosive chemicals, fumes, heat or direct sunlight.
- Store cylinders by gas type, separating oxidizing gases from flammable gases. Store flammable and oxidizing gases either 20 ft apart or separated by a 30 minute fire wall, five feet high.
- Keep a minimum number of cylinders on hand.
- All cylinders and compressed gases (full or empty) should be properly fastened and supported by straps, belts, buckles or chains to prevent them from falling and causing bodily harm or becoming a projectile. A maximum of two cylinders per restraint is preferred.
- Close valves and relieve pressure on cylinder regulators when cylinders are not in use.
- Valve handles must be in place when cylinders are in use.
- **DO NOT** smoke in areas where there are flammable gases.
- **DO NOT** extinguish a flame caused by a gas until the gas source has been shut off.
- A cylinder should only be moved while strapped to a wheel cart to ensure stability. When storing or moving cylinders, always attach safety caps.
- **DO NOT** heat the cylinder or place a cylinder where it may become part of an electrical circuit. Compressed gases must be handled as high-energy sources and dangerous projectiles.
- All cylinders should be checked for damage prior to use. **DO NOT** repair damaged cylinders yourself. Damaged or defective cylinders, valves, etc., must be taken out of use immediately and returned to the manufacturer for repair.
- Each regulator valve should be inspected annually. Never force valve or regulator connections. Threads and the configuration of valve outlets are different for each family of gases to prevent mixing of incompatible gases.
- When opening a cylinder, direct the cylinder opening away from personnel and open slowly.
- **DO NOT** use lubrication on valve regulators.
- **Do not** refill a cylinder with a material other than that originally contained in the cylinder.
- **Do not** alter cylinder labeling.
- **Do not** alter the cylinder pressure by use of an external heat source.
- If an inert, flammable or toxic gas cylinder develops a small leak at the valve, carefully remove the cylinder to a hood or open space outdoors away from any possible source of ignition and all populations.

Cryogenic Materials

Cryogenic materials have special properties that make them particularly hazardous to use in the solid, liquid or gaseous states. They are characterized by severe low temperature (-60°C to - 270°C). Cryogenic temperatures are achieved by liquefaction of gases, most commonly helium, hydrogen, nitrogen, argon, oxygen or methane.

Storage and Handling

- The severely cold temperatures associated with cryogenic liquids (-60°C to -270°C) can damage living tissue on contact and embrittle structural materials.
- Liquified under pressure, cryogenic liquids must be kept in specially designed, high-pressure vessels that contain fittings to relieve overpressure. When located in moist areas, ice formation can plug pressure release devices and pose an explosion hazard. For this reason, store vessels in a dry place and periodically check for ice formation.
- Cryogenic liquids present fire and explosion hazards. A flammable mixture, cooled in the presence of air with liquid nitrogen or liquid oxygen, can cause oxygen to condense and thereby present an explosion hazard. Keep away from ignition sources. Flammable liquids will support combustion in both the liquid and gaseous states. If allowed to depressurize, cryogenic liquids will rapidly and violently expand.
- Store and work with cryogenic liquids in a well-ventilated area to prevent the accumulation of flammable, toxic or inert gases as evaporation and condensation occurs near the cryogenic tank.
- Safety glasses and face shields should be used. For handling of cryogenic liquids, use potholders or appropriate thermal gloves. (Check with the glove manufacturer to assure the gloves will protect against the extreme temperatures of cryogenic material used.)
- Cushion glassware in a protective covering to prevent injury caused by flying glass in the event of implosion/explosion.
- Transport fragile cryogenic containers with caution -- use a hand truck if appropriate.
- Vent cryogenic storage containers outdoors or into a chemical fume hood system.
- Cryogenic gases **ALWAYS** pose a high pressure hazard since they are stored near boiling point. Liquid to gas evaporation causes high pressures to build up.

LABELING, MATERIAL SAFETY DATA SHEETS, AND INFORMATION AND TRAINING

LABELING

LABELS should be the primary, initial source of warning for employees when handling hazardous chemical substances. Regulations mandate that all labels on original/stock containers of hazardous chemicals include the name of the hazardous chemical, appropriate hazard warnings, safety precautionary measures and the name and address of the manufacturer or other responsible party.

- ❖ Substances regulated by a **specific** OSHA standard must be labeled by the manufacturer according to the requirements of that standard. EXAMPLE:
    - ➢ OSHA 1910.1018(p) -- The Inorganic Arsenic Standard states that containers of inorganic arsenic must have a label which bears the following information:

DANGER
CONTAINS INORGANIC ARSENIC
CANCER HAZARD
HARMFUL IF INHALED OR SWALLOWED
USE ONLY WITH ADEQUATE VENTILATION

Hazard Information

- Hazard warnings found on the labels of hazardous chemical containers may be composed of **pictures**, **symbols** and **words**, or any combination thereof which convey the hazard(s) of the chemical.
- Picture hazard warnings help to identify the following properties and classes of hazardous compounds.
  - explosives
  - oxidizers
  - flammables
  - corrosives
  - poisons
  - compressed gases
  - radiation
  - biohazards

- Symbol hazard warnings provide basic information in determining what precautionary measures to use when handling hazardous chemical substances and/or dealing with a fire.
  - The National Fire Protection Association (NFPA) uses a symbol system designed as a diamond-shaped label containing four differently colored squares:

    BLUE SQUARE ~ HEALTH HAZARD
    RED SQUARE ~ FLAMMABILITY
    YELLOW SQUARE ~ REACTIVITY
    WHITE SQUARE ~ "SPECIAL HAZARDS"

  - A number (0 - 4) is added to each square indicating the order of hazard severity:

    0 = NO SPECIAL HAZARDS
    4 = SEVERE HAZARD

- Word hazard warnings contain a word or words intended to capture the worker's **immediate attention** (e.g., flammable, poison, fatal if swallowed). These word labels should be in English, but other languages may be used where needed.
  - Signal words are warnings used to designate the degree of hazard.

    DANGER ~ Highest degree of hazard (Red)
    WARNING ~ Intermediate degree of hazard (Orange)
    CAUTION ~ Lowest degree of hazard (Yellow)

Label Use

- Laboratory supervisors should ensure that all incoming containers of hazardous materials bear a label specifying: materials as stipulated in *Occupational Safety And Health (Classification, Packaging And Labelling Of Hazardous Chemical) Regulations, reg 4*
  - the name of the hazardous chemical.
  - the appropriate hazard warning.
  - safety precautionary measures
  - the name and address of the manufacturer or other responsible party.
- Laboratory workers should not remove or deface labels on containers of hazardous chemicals.
- When chemicals are transferred from the manufacturer's original container to a secondary container, that new container should be appropriately labeled as to chemical identity and hazard warning.
  - EXCEPTION: Unless the contents of the secondary vessel are to be used during the workshift by the person who performed the original transfer.

MATERIAL SAFETY DATA SHEETS (MSDSs)

MSDSs are a major product-specific information resource for chemicals purchased for use in UCSI laboratories. OSHA requires chemical manufacturers and importers to produce one MSDS for each hazardous chemical they manufacture or import. These MSDSs should be maintained by the lab.

MSDS Requirements

- The MSDS must include the following information: as stipulated in *Occupational Safety And Health (Classification, Packaging And Labelling Of Hazardous Chemical) Regulation, reg 9 and Occupational Safety And Health (Use And Standards Of Exposure Of Chemical Hazardous To Health) Regulations, reg 24 and reg 25.*
    - The identity of substance designated on the container label.
        - Single substance: chemical and common names.
        - Mixtures tested as a whole: chemical and common names of all ingredients which are health hazards, in concentrations of 1% or greater.
        - Mixtures untested as a whole: chemical and common names of all ingredients which are health hazards and which are in concentrations of 1% or greater; carcinogens in concentration of 0.1% or greater; hazard determinations are based upon the characteristic of the individual products instead of the combined mixture.
    - Physical and chemical characteristics of the hazardous chemicals.
    - Physical hazards (potential for fire, explosion, etc.)
    - Known acute and chronic health effects and related health information.
    - Primary routes of entry into the body.
    - Information on exposure limits.
    - Whether a hazardous chemical is considered a carcinogen by OSHA, the International Agency for Research on Cancer, or the National Toxicology Program.
    - Precautions for safe handling.
    - Generally acceptable control measures (engineering controls, work practices, personal protective equipment).
    - Emergency and first aid procedures.
    - Date of MSDS preparation, or most recent change.
    - Name, address, and phone number of the party responsible for preparing and distributing the MSDS.
- A MSDS may be used for similar mixtures with essentially the same hazards and contents.
- Copies of MSDSs must be readily accessible during work hours.

INFORMATION AND TRAINING

In accordance with regulations, all laboratory personnel have the right to be informed and trained on the chemical hazards present in their work area. The responsibility for apprising laboratory workers of the necessary precautions to take when using or handling hazardous materials rests with the **Laboratory Supervisor ((LS)** or Principal Investigator (PI) in charge of the laboratory. Ultimately your safety in the lab depends on you! So take the time to learn about the hazards, the precautions to be taken, and carry out your role safely. If you have questions, ask your supervisor as stipulated in *Occupational Safety and Health (Use and Standards Of Exposure Of Chemical Hazardous to Health) Regulations, reg 23.*

Employee Orientation

- Regulations mandate that all laboratory personnel attend training in using or handling hazardous materials, and that records of attendance be kept.
- Chemical safety information and training should be provided at the time of a laboratory worker's initial arrival to the lab area, and prior to new exposure situations. This can only be done by the LS or PI in charge of the lab.

Employee Information

Before working in the laboratory setting, all laboratory workers should know the following:

- All procedures in the work area where hazardous materials are present, including emergency procedures.
- Location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory. These references include the MSDSs.
- How to review MSDSs, where they are kept, and how to obtain an MSDS for a particular chemical.

- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
- Permissible exposure limits (PEL) for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no specific OSHA standard.
- If you have any specific questions about MSDSs, laboratory safety, or chemical hazards, consult your supervisor.

Employee Training

- All laboratory workers have the right to be trained on any potentially hazardous chemical or product used in the work area. Training should include:
    - Methods and observations that may be used to detect the presence or release of a hazardous chemical (i.e., continuous monitoring devices, visual appearances, or odors of hazardous chemicals when being released).
    - Physical and/or health hazards associated with hazardous materials in the work area.
    - Safety measures laboratory workers may use to protect themselves such as appropriate work practices, emergency procedures, and personal protective equipment.

Record- keeping

At the conclusion of any general information/training session with laboratory workers, records of attendance will be inserted into employees' personnel files. Faculty members/laboratory supervisors who provide specific training are advised to obtain a signed statement from employees indicating that they have received the appropriate training.

ACCESS TO MSDSs

- You may access MSDSs by any of the following methods:
    - Contact your LS or PI. A department or laboratory set of MSDSs may be available for your use.
    - A copy of the Merck MSDS database is available in the lab computer.
    - Contact the product manufacturer, importer or distributor and request a copy.

Appendix I

Types of Respirators. The following is a description of different types of respirators.

Commonly Used Respirators (Air Purifying)

- Disposable Dust masks are worn over the nose and mouth to protect the respiratory system from certain nuisance dusts, mists, etc. They can only provide protection against particular contaminants as specified by the manufacturer (e.g., general dust, fiberglass, etc.). These dust masks cannot be fit tested, and are generally single use. They are not recognized as respiratory protection and may not be worn if a potential for overexposure exists.
- Half-Face Respirators with interchangeable filter cartridges can protect the respiratory system from hazardous dusts, fumes, mists, etc. They can only provide protection against certain contaminants up to limited concentrations specified by the manufacturer for the particular cartridge type used (e.g., toluene, acetone). These generally operate under negative pressure within the respirator which is created by the wearer's breathing through the filter cartridges. As the protection is only gained if there is a proper seal of the respirator face piece, this type requires fit testing prior to respirator assignment and a fit check prior to each use.
- Full-Face Respirators operate under the same principle and requirements as the half-face type, however, they offer a better facepiece fit and also protect the wearer's eyes from particularly irritating gases or vapors.
- Full-face, helmet or hood type powered air purifying respirators (PAPRs) operate under positive pressure inside the facepiece using a battery operated motor blower assembly to force air through a filter cartridge into the wearer's breathing zone.

Less Commonly Used Types Respirators (Air Supplying)

- Air-Line Respirators supply clean air through a small diameter hose from a compressor or compressed air cylinders. The wearer must be attached to the hose at all times, which limits mobility. Use of these respirators is subject to the manufacturers' guidelines.

Self-Contained Breathing Apparatus (SCBA) respirators supply clean air from a compressed air tank carried on the back of the wearer. These types of respirators are highly mobile and are used primarily for emergency response or rescue work, since only a limited amount of air can be supplied by a single tank, generally 20-60 minutes. Units must be thoroughly inspected on a monthly basis and written records must be kept of all inspections, operator training, etc. Use of these respirators is subject to the manufacturer's guidelines and enrollment in the UMCP respiratory protection program.

Appendix II

GLOVE CHEMICAL RESISTANCE GUIDE[1]

	Silver Shield (4 Mil)			Viton (9 Mil)			Butyl (17 Mil)			Nitrile (11 Mil)			Neoprene(22 Mil)			PVC (20 MIL)		
CHEMICAL	D	BT	PR	D	BT	PR	D	BT	PR	D	BT	PR	D	BT	PR	D	BT	PR
Acetaldehyde	E	>6h	ND	P	0m	281.9	E	9.6	0.07	F	4m	161	E	21m	18	ID	ID	ID
Acetone	E	>6h	ND	P	ID	ID	E	>17h	ND	P	ID	ID	E	12m	35	P	>1m	>>
Acetonitrile	E	>8h	ND	ID	ID	ID	E	>8h	ND	ID	ID	ID	E	40m	7	ID	ID	ID
Acrylic Acid	ID	ID	ID	G	5.9h	0.23	E	>8h	ND	F	ID	ID	ID	ID	ID	ID	ID	ID
Acrylonitrile	E	ID	ID	F	1m	176	G	3.1h	<0.01	P	3m	176	ID	ID	ID	ID	ID	ID
Aldehyde	E	>6h	ND	P	0m	281.9	E	9.5h	0.07	P	4	161	ID	ID	ID	ID	ID	ID
Aniline	E	>8h	ID	G	10m	18.7	F	>8h	ND	P	1.1h	45	E	>8h	ND	G	>8h	ND
Benzaldehyde	ID	ID	ID	F	9.9h	4	E	9h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
Benzene	E	>8h	ND	G	6h	0.012	P	31m	32.3	P	ID	ID	ID	16m	133	ID	2m	250
Benzoyl Chloride	ID	ID	ID	E	>8h	ND	F	6.2h	16.6	P	ID	ID	ID	ID	ID	ID	ID	ID
Bromobenzene	E	ID	ID	E	8h	ND	P	32m	39.8	P	13m	9.1	ID	ID	ID	ID	ID	ID
Butyl Acetate	E	>6h	ND	P	ID	ID	G	1.9h	7.61	P	29m	54.4	ID	52m	53	ID	ID	ID
p-t Butyltoluene	E	>8h	ND	E	>8h	ND	G	1.7h	8	P	ID	ID	ID	ID	ID	ID	ID	ID
Butyraldehyde	E	ID	ID	P	54m	9	E	>15h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
Carbon Disulfide	G	>8h	ND	E	>8h	ND	P	7m	98	P	1m	51	ID	ID	ID	ID	ID	ID
Carbon Tetrachloride	E	>6h	ND	E	>13h	ND	P	ID	ID	G	3.4h	5	F	31m	252	ID	ID	ID
Cellosolve	G	>6h	ND	F	ID	ID	G	ID	ID	P	ID	ID	E	5.9h	3	ID	ID	ID
Chlorobenzene	E	ID	ID	E	>8h	ND	P	35m	308	P	ID	ID	ID	ID	ID	ID	ID	ID
Chloroform	P	10m	0.009	E	9.5h	0.46	P	ID	ID	P	4m	352	P	12m	220	ID	ID	ID
Chloronaphthalene	E	>8h	ND	E	>16h	ND	P	ID	ID	P	2.9h	>1.3	ID	ID	ID	ID	ID	ID
Chloroprene	ID	ID	ID	ID	>8h	ND	P	28m	18	ID	ID	ID	ID	ID	ID	ID	ID	ID
Cyclohexane	E	>6h	ND	E	>7h	ND	P	1.1h	20.3	P	ID	ID	E	2.7h	7	ID	16m	17
Cyclohexanol	E	>6h	ND	E	>8h	ND	E	>11h	ND	E	>16h	ND	ID	ID	ID	ID	ID	ID
Cyclohexanone	E	>6h	ND	P	29m	86.3	E	>16h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
Dibutylphthalate	E	>6h	ND	E	>8h	ND	E	>16h	ND	E	>16h	ND	ID	ID	ID	ID	ID	ID
1,1,Dichloroethane	ID	2.4h	6	G	1.5h	31	ID	ID	ID	P	ID	ID	ID	ID	ID	ID	ID	ID
1,2,Dichlorothane	E	>6h	ND	E	6.9	0.81	P	2h	53	P	8m	311	P	33m	247	ID	ID	ID
Diethylamine	E	>8h	ND	P	35m	852	P	47m	46	F	ID	ID	ID	ID	ID	ID	ID	ID
Diethylaminoethanol	E	ID	ID	E	>8h	ND	E	>8h	ND	E	>8h	ND	ID	ID	ID	ID	ID	ID
1,4-Diethylene Dioxide	ID	>8h	ND	P	23m	26.8	E	>20h	ND	P	28m	77.1	ID	28m	62	ID	8m	250
Diethyleneltriamine	ID	ID	ID	E	>8h	ND	E	>8h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
Diisobutyl Ketone 80%	E	>6h	ND	F	1.2h	90.6	G	3.3h	41.2	F	3h	48.9	ID	ID	ID	ID	ID	ID
Dimethyl Acetamide	ID	1.5h	0.728	P	25m	3	ID	>8h	ND	ID	ID	ID	ID	ID	ID	ID	ID	ID
Dimethyl Formamide	E	>8h	ND	P	8m	6.5	E	>8h	ND	F	1m	>15	ID	ID	ID		ID	ID
Dimethylsulfoxide	G	ID	ID	F	1.5h	5	E	>8h	ND	F	ID	ID	ID	ID	ID	ID	ID	ID
Dioxane	E	>8h	ND	F	23m	26.8	E	>20h	ND	P	28m	77.1	ID	28m	62	ID	8m	250
Divinyl Benzene	E	>8h	ND	E	>17h	ND	F	2.2h	238	P	ID	ID	ID	ID	ID	ID	ID	ID
Epichlorohydrin	ID	ID	ID	P	2h	4	G	>8h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
Ether	ID	>6h	ND	P	12m	21.5	P	8m	92.2	P	14m	21.8	ID	ID	ID	ID	ID	ID
Ethyl Acetate	E	>6h	ND	P	ID	ID	G	7.6h	3.4	P	8m	145	G	34m	178	ID	ID	ID
Ethyl Ether	ID	>6h	ND	P	12m	21.5	P	8m	92.2	P	14m	21.8	E	18m	51	ID	ID	ID
Ethylamine 70%	E	47m	7.64	P	ID	ID	E	>12h	ND	F	1.1h	30.1	ID	ID	ID	ID	ID	ID
Ethylene dibromide	E	ID	ID	E	>8h	ND	F	3.3h	6	P	ID	ID	ID	ID	ID	ID	ID	ID
Formaldehyde 37%	E	>6h	ND	E	>16h	ND	E	16h	ND	E	>21h	ND	E	>8h	ND	G	8h	ND
Furan	ID	ID	ID	P	20m	23	P	1.3h	10	P	ID	ID	ID	ID	ID	ID	ID	ID
Furfural	E	>8h	ND	F	3.6h	14.8	E	>16h	ND	P	28m	265	ID	ID	ID	ID	ID	ID
Glutaraldehyde	E	ID	ID	E	>8h	ND	E	>8h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
n-Hexane	E	>6h	ND	ID	>11h	ND	P	ID	ID	E	ID	ID	E	39m	5	ID	ID	ID
Hydrazine 70%	G	>6h	ND	P	ID	ID	E	>8h	ND	G	>8h	ND	E	>8h	ND	E	8h	ND
Hydrochloric Acid 37%	E	>6h	ND	E	ID	ID	E	ID	ID	P	ID	ID	E	>8h	ND	E	>8h	ND
Hydrofluoric Acid 50%	G	>6h	ND	G	ID	ID	F	ID	ID	P	ID	ID	E	>8h	ND	E	1.8h	0
Isobutyl Alcohol	E	ID	ID	E	>8h	ND	E	>8h	ND	G	>8h	ND	ID	ID	ID	ID	ID	ID
Isobutyraldehyde	E	ID	ID	P	4m	11.5	E	>8h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
Methacrylic Acid	ID	ID	ID	F	>8h	ND	G	>8h	ND	P	1.7h	23	ID	ID	ID	ID	ID	ID
Methacrylonitrile	E	ID	ID	F	4m	462	G	6.8h	0.001	P	7m	560	ID	ID	ID	ID	ID	ID
Methyl Chloroform	ID	>6h	ND	E	>15h	ND	P	ID	ID	P	41m	76.4	P	27m	197	ID	ID	ID
Methyl Cyanide	ID	>8h	ND	ID	ID	ID	E	>8h	ND	ID	ID	ID	E	40m	7	ID	ID	ID
Methyl Ethyl Ketone	E	>24h	ND	P	ID	ID	E	>8h	ND	P	ID	ID	G	22m	155	ID	1m	>>
Methyl Isocyanate	ID	ID	ID	P	4m	121	P	1.1h	9	P	ID	ID	ID	ID	ID	ID	ID	ID

GLOVE CHEMICAL RESISTANCE GUIDE[1]

	Silver Shield (4 Mil)			Viton (9 Mil)			Butyl (17 Mil)			Nitrile (11 Mil)			Neoprene(22 Mil)			PVC (20 MIL)		
CHEMICAL	D	BT	PR	D	BT	PR	D	BT	PR	D	BT	PR	D	BT	PR	D	BT	PR
Methylamine 40%	F	1.9h	2	E	>16h	ND	E	>15h	ND	G	>8h	ND	ID	ID	ID	ID	ID	ID
Methylene Chloride	G	>8h	ND	F	1h	7.32	P	24m	133	P	4m	766	F	6m	239	ID	ID	ID
Methylene Dianiline	E	>24h	ND	E	>8h	ND	E	>24h	ND	F	ID	ID	ID	ID	ID	ID	ID	ID
Methylene Dichloride	ID	1.9h	0.002	G	1.9h	7.32	P	ID	ID	P	4m	766	ID	ID	ID	ID	ID	ID
Morpholine	E	>8h	ND	G	ID	97	E	>16h	ND	P	48m	206	ID	ID	ID	ID	ID	ID
Nitric Acid, 3 Molar	E	>6h	ND	G	>8h	ID	F	ID	ID	P	ID	ID	E	>8h	ND	E	1.9h	0
Nitrobenzene	E	>8h	ND	E	21m	ND	E	>23	ND	F	33m	1.7	G	1h	20	ID	ID	ID
Nitropropane	E	>8h	ND	P	>8h	26.1	E	>8h	ND	P	16m	29.5	ID	ID	ID	ID	ID	ID
Oxalic Acid	E	>8h	ND	E	>8h	ND	E	>8h	ND	G	ID	ID	ID	ID	ID	ID	ID	ID
PCB, Aroclor 1254 50%	E	>8h	ND	E	>13h	ND	P	ID	ID	F	ID	ID	ID	ID	ID	ID	ID	ID
Pentachlorophenol 1%2	E	>8h	ND	ID	>8h	ND	P	ID	ID	E	>13h	ND	ID	8h	ND	ID	ID	ID
n-Pentane	E	>6h	ND	E	>17h	ND	P	ID	ID	E	ID	ID	ID	38m	3	ID	9m	17
Perchlorethylene	E	>6h	ND	E	>15h	ND	P	ID	ID	F	>1.3h	5.5	ID	28m	75.5	ID	ID	ID
Phenol 85%, water sat	G	>6h	ND	E	ID	ND	E	>20h	ND	P	39m	>1500	E	>8h	ND	ID	32m	13
Propyl Acetate	E	>6h	ND	P	ID	ID	G	2.7h	2.86	P	17m	72.5	ID	ID	ID	ID	ID	ID
Propyelenediamine	ID	ID	ID	E	38m	ND	E	>8h	ND	F	ID	ID	ID	ID	ID	ID	ID	ID
Pyridine	ID	ID	ID	P	ID	74	G	>8h	ND	P	ID	ID	ID	28m	117	ID	1m	>>
Red Fuming Nitric Acid	P	35m	ID	P	ID	ID	P	ID	ID	P	ID	ID	ID	ID	ID	ID	ID	ID
Sodium Hydroxide 50%	E	>6h	ND	G	ID	ID	E	ID	ID	G	ID	ID	E	>6.7h	ND	E	8h	ND
Styrene	G	>4h	ND	G	ID	ID	P	ID	ID	P	ID	ID	ID	ID	40	ID	27m	40
Sulfuric Acid, 3 Molar	E	>6h	ND	E	ID	ID	G	ID	ID	P	ID	ID	E	>6.7h	ND	E	>8h	ND
Tetrachloroethylene	E	>6h	ND	E	>17h	ND	P	ID	ID	F	1.3h	5.5	ID	28m	75.5	ID	ID	ID
Tetraethylenepentamine	ID	ID	ND	E	>8h	ND	E	>8h	ND	F	ID	ID	ID	ID	ID	ID	ID	ID
Tetrafluoroethylene	E	ID	ID	E	>8h	ND	E	>8h	ND	ID	ID	ID	ID	ID	ID	ID	ID	ID
Tetrahydrofuran	E	>8h	ND	P	4m	327	F	31m	112	P	4m	167	P	11m	671	ID	1m	>>
Thiophene	ID	>6h	ND	E	>8h	ND	P	1.8h	17	P	ID	ID	ID	ID	ID	ID	ID	ID
Sodium Hydroxide 50%	E	>6h	ND	G	ID	ID	E	ID	ID	G	ID	ID	E	>6.7h	ND	E	8h	ND
Styrene	G	>4h	ND	G	ID	ID	P	ID	ID	P	ID	ID	ID	ID	40	ID	27m	40
Sulfuric Acid, 3 Molar	E	>6h	ND	E	ID	ID	G	ID	ID	P	ID	ID	E	>6.7h	ND	E	>8h	ND
Tetrachloroethylene	E	>6h	ND	E	>17h	ND	P	ID	ID	F	1.3h	5.5	ID	28m	75.5	ID	ID	ID
Tetraethylenepentamine	ID	ID	ND	E	>8h	ND	E	>8h	ND	F	ID	ID	ID	ID	ID	ID	ID	ID
Tetrafluoroethylene	E	ID	ID	E	>8h	ND	E	>8h	ND	ID	ID	ID	ID	ID	ID	ID	ID	ID
Tetrahydrofuran	E	>8h	ND	P	4m	327	F	31m	112	P	4m	167	P	11m	671	ID	1m	>>
Thiophene	ID	>6h	ND	E	>8h	ND	P	1.8h	17	P	ID	ID	ID	ID	ID	ID	ID	ID
Toluene	E	>6h	ND	E	>16h	ND	F	21m	22.1	P	11m	68.1	ID	14m	576	ID	3m	350
Toluene Diisocyanate	E	>8h	ND	E	>16h	ND	E	>8h	ND	G	3.7h	1.8	ID	ID	ID	G	>6.7	ND
Trichloroethane	E	>6h	ND	G	7.4h	0.24	P	18m	550	P	8m	283	ID	11m	881	ID	ID	ID
1,1,1 Trichloroethane	E	>6h	ND	E	>15h	ND	P	ID	ID	F	41m	76.4	P	27m	197	ID	ID	ID
1,1,2 Trichloroethane	ID	ID	ID	E	>8h	ND	P	5.7h	7	P	ID	ID	ID	ID	ID	ID	ID	ID
Triethylamine	ID	ID	ID	E	>8h	ND	P	ID	ID	E	>8h	ND	ID	ID	ID	ID	ID	ID
Vinyl Chloride	E	>8h	ND	G	4.4h	0.098	P	ID	ID	G	5.7h	0.14	ID	ID	ID	ID	ID	ID
Xylene	E	>24h	ND	E	>8h	ND	P	ID	ID	P	ID	ID	ID	23m	135	ID	4m	383

[1]The data for Silver Shield™, Viton™, Butyl and Nitrile gloves were provided by Siebe North Inc, Charleston, SC; information on Neoprene and Polyvinyl Chloride (PVC) gloves were supplied by Pioneer Industrial Products, Williard, OH.

[2]In Kerosene

E=Excellent; G=Good; F=Fair; P=Poor; ND=None detected; ID=Insufficient Data; D=Degradation;
BT=Breakthrough, amount of elapsed time after initial exposure before the chemical can be analytically detected on the inside surface of the glove;
PR=Permeation Rate is expressed in mg/m2/sec. PR can be used for estimating glove thickness required; for a given material, thicker is more resistant.

Note: Silver Shield gloves may be worn as liners under other glove types to enhance protection.

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Mil = unit of thickness; 1 Mil = 0.001 inch (1/1000th of an inch)
Another Chemical Resistance Guide for gloves may be found in the website www.ansellpro.com and you may download the pdf file for your own reference.

Appendix III

Summary of Biosafety Levels Recommended for Infectious Agents

Biosafety Level	Practice Technique	Safety Equipment	Facilities
1	Standard Microbiological Practices	None: Primary containment provided by adherence to standard laboratory practices during open bench work.	Basic
2	Level 1 practices PLUS: laboratory coats; decontamination of all infectious wastes; limited access; protective gloves and biohazard warning signs as indicated.	Partial containment equipment (e.g., Class I or II Biosafety Cabinets) used to conduct mechanical and manipulative procedures that have high aerosol potential that may increase the risk of exposure to personnel.	Basic
3	Level 2 practices PLUS: special laboratory clothing; controlled access.	Partial containment equipment used for all manipulations of infectious materials.	Containment
4	Level 3 practices PLUS: entrance through a change room where street clothing is removed and laboratory clothing is put on; shower on exit; all wastes are decontaminated on exit from the facility.	Maximum containment equipment (e.g., Class III Biosafety Cabinet or partial containment equipment in combination with full-body, air supplied, positive-pressure personnel suit) used for all procedures and activities.	Maximum Containment

A full description of each biosafety level recommendation is available through the Ministry of Natural Resources and Environment – biosafety@nre.gov.my.

Appendix IV

TABLE OF INCOMPATIBLE CHEMICALS

The following substances may react violently with one another and must be kept apart.

Chemical	Is Incompatible with
Acetic acid	Chromic acid, nitric acid, alcohols, ethylene glycol, perchloric acid, peroxides, permanganates
Acetone	Concentrated nitric and sulfuric acid mixtures
Acetylene	Chlorine, bromine, fluorine, copper, silver, mercury
Acids	Bases
Activated Carbon	Calcium hypochlorite, oxidizing agents
Alkali Metals	Water, carbon tetrachloride and other halogenated alkanes, carbon dioxide, halogens
Aluminum Alkyls	Water
Ammonia	Mercury (e.g., in pressure gauges), laboratory gas chlorine, calcium hypochlorite, iodine, bromine, hydrogen fluoride
Ammonium organic Nitrate	Acids, powered metals, flammable liquids, chlorates, nitrates, sulfur, fine-particulate or combustible materials.
Aniline	Nitric acid, hydrogen peroxide
Azides	Acids
Bases	Acids
Bromine	See chlorine
Carbon Tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powered metals, sulfur, fine-particulate organic or combustible substances
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane, hydrogen, petroleum benzine, benzene, powered metals
Chromic Acid	Acetic acid, naphthalene, camphor, glycerol, petroleum benzine, alcohols, flammable liquids
Copper	Acetylene, hydrogen peroxide

Chemical	Is Incompatible with
Cumene Hydroperoxide	Acids, both organic and inorganic
Cyanides	Acids
Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	Store separately
Hydrocarbons (butane, propane, benzene, etc.)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrogen Fluoride	Ammonia, laboratory gas or solution
Hydrogen Peroxide	Copper, Chromium, iron, metals and metals salts, alcohols, acetone, organic substances, aniline, nitromethane, combustibles (solid or liquid)
Hydrogen Sulfide	Fuming nitric acid, oxidizing gases
Iodine	Acetylene, ammonia (laboratory gas or solution)
Mercury	Acetylene, ammonia
Nitric Acid, Conc.	Acetic acid, aniline, chromic acid, prussic acid, hydrogen sulfide, flammable liquids and gases
Oxalic Acid	Silver, mercury
Perchloric Acid	Acetic anhydride, bismuth and its alloys, alcohols, paper, wood
Phosphorus	Sulfur, oxygen-containing compounds with such as chlorates
Potassium	See alkali metals
Potassium Chlorate	See chlorates
Potassium Perchlorate	See chlorates
Potassium Permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds.

INCOMPATIBLE SUBSTANCE (Continued)

Chemical	Is Incompatible with
Sodium	See alkali metals
Sodium Peroxide	Methanol, ethanol, glacial acetic acid, anhydride, benzaldehyde, Carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfuro
Sulfides	Acids
Sulfuric Acid	Potassium chlorate, potassium perchlorate, potassium permanganate

Please note: This is not an exhaustive list of incompatible chemicals. See the specific lab standard operating procedures or Lecturer / Supervisor / Laboratory Technologist / Principal Investigator to determine additional material incompatibilities of which to be aware.

Appendix V

Section 5 of the UCSI University Campus Emergency Guide

5. FIRE EMERGENCY

The main causes of fire are sources of heat such as:

- Electricity
- Static Electricity
- Sparks
- Friction
- Mechanical heat
- Chemical reaction
- Compressed gas
- Lighting
- Flames

Other causes of fire are fuels such as

- Combustible solids, for eg. wood, tables, chairs, paper.
- Combustible liquids, for eg. petrol, paraffin, diesel, methanol, and ethanol.
- Combustible gases, for eg. hydrogen, methane, butane, and carbon monoxide.
- Combustible metals, for eg. Kalium (potassium), Natrium (sodium), Calcium, and Magnesium.

Prevention is better than cure.

5.1 How and why fires happen

a. Natural factor: Fire caused by a disaster or a natural factor.
b. Accidental factor: Fire caused by negligence, carelessness or plain human error.
c. Incendiary factor: Fire caused by deliberate or malicious human act/criminal intention and action.

5.2 Ten basic control strategies

a. Ensure that the firefighting equipment is **adequately maintained.**
b. Ensure that all firefighting equipment is properly **handled** and in good working condition.
c. Occupants should be **trained** in using fire-fighting equipment.
d. Firefighting equipment should be located at the **firefighting access areas** and clearly **displayed.**
e. **Emergency Telephone Numbers** are to be displayed at strategic places.
f. **Evacuation and Assembly Points** need to be identified and clearly marked.

g. A **First Aid** kit should be made ready and available at all times.
h. All occupants must be **instructed** to notify internal security and the Fire & Rescue Department, if a fire breaks out.
i. **Tests and Inspections** of the fire-fighting equipment should be done regularly.
j. Ensure that all fire doors at the fire-fighting access areas are **shut** at all times.

5.3 If a fire alarm is activated

a. Evacuate the building immediately; close doors behind you.
b. **Do not** try to save belongings, files, or equipment.
c. **Do not** go to the basement.
d. **Do not** use elevators.
e. Help people with disabilities (non-wheelchair) leave building if possible.
f. If disabled persons cannot be evacuated, lead them to the nearest enclosed stairwell and close doors leading to the stairwell.
g. Tell Fire personnel the location of disabled persons remaining in the building.
h. Proceed to the designated meeting point at least 100 metres away from the building. Follow the signs indicating the path to the point of assembly.
i. Stay clear of firefighting equipment and personnel.

5.4 If a fire is discovered

a. Evacuate the building immediately.
b. **Do not** use elevators.
c. **Activate** the closest **fire alarm** as you exit, if possible.
d. **Tell Fire personnel** the location of **disabled persons** remaining in the building.
e. Use fire extinguisher **only if** trained in its proper use.

5.5 If your clothes catch fire

a. **Stop** whatever you are doing; do not run.
b. **Drop** to the ground.
c. **Roll** to smother flames.

5.6 Render First Aid as necessary

a. Do not attempt to move a person with extreme injuries
b. Get help from Fire or Police personnel.

Appendix VI

GLOSSARY

Absolute A chemical substance that is relatively free of impurities.

Absorb The penetration of a solid substance by a liquid as by capillary, osmotic, solvent or chemical action. Chemicals are readily absorbed into the human blood stream through the eyes or cuts in the skin

Acid An organic or inorganic compound with a pH of less than 7. Acidic materials are corrosive to human tissue.

Action Level A concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Acute Toxicity Refers to adverse effects suffered as the result of a short, one-time exposure to toxic materials. It occurs within a relatively short period. Exposure is measured in seconds, minutes, or hours relative to inhalation or skin absorption.

Adsorb Collection of gas or liquid molecules on the surface of another material. For sampling of most organic vapors, activated charcoal is a good adsorber.

Base Chemical compounds that have a pH of greater then 7. Bases are also referred to as alkalis or caustic materials and can be corrosive to human tissue.

Boiling Point The temperature at which the vapor pressure of a liquid is equivalent to the surrounding atmospheric pressure, and the liquid rapidly becomes a vapor. Flammable substances possessing low boiling points are considered fire hazards.

Carcinogen A chemical is considered to be a carcinogen if:

(a) it has been evaluated by the International Agency for Research on Cancer [IARC] and found to be a carcinogen or potential carcinogen;

(b) It is listed as a carcinogen or potential carcinogen in the *Annual Report on Carcinogens* published by the National Toxicology Program (NTP) (latest edition);
or

(c) It is regulated by OSHA as a carcinogen.

Caustic Any strongly alkaline material that produces either corrosion or irritation to living tissue.

Chemical Hygiene Plan A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace.

Chemical Reactivity The ability of a material to chemically change, possibly resulting in explosion hazards or the liberation of toxic fumes.

Chronic Toxicity Adverse health effects resulting from repeated or long-term exposure to toxic materials.

Combustible Liquid Any liquid having a flashpoint at or above 100°F (37.8°C) but below 200°F (93.3°C), except any mixture having components with flashpoints of 200°F (93.3°C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture by OSHA and NFPA definition.

Compressed Gas

(a) A gas, or mixture of gases having in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C); or

(b) A gas, or mixture of gases having in a container, an absolute pressure exceeding104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or

(c) A liquid having a vapor pressure exceeding 40 psi at 100°F(37.8°C) as determined by ASTM D-323-72.

Corrosive A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.

Cryogenic Liquid Severely cold (-60°C to -270°C) and pressurized liquids. They present an explosion hazard due to high pressures and can cause thermal damage to living tissue.

Designated Area An area that must be assigned by the Principle Investigator or Lab Supervisor for the use of "select carcinogens" reproductive toxins, or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

Embryotoxin A substance shown to adversely affect a developing embryo at a particular concentration, but does not affect the pregnant female.

Explosive A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable Gas A gas that forms a flammable mixture with air at a concentration of 13 percent by volume or less, or forms a range of flammable mixtures with air that are wider than 12% by volume, regardless of lower flammable limit.

Flammable Liquid Any liquid having a flashpoint below 100°F (37.8°C) except any mixture having Liquid components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

Flammable Solid A solid that is liable to cause a 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.

Flammability The ease with which a liquid, solid, or gas will ignite, either spontaneously (pyrophoric) or as the result of a spark or an open flame. The more flammable a material, the more readily ignition occurs.

Flashpoint The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite.

Fume Hood A device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any part of the employee's body other than hands and arms.

Hazardous Chemical A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are 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.

Highly Toxic A chemical falling within any of the following categories:

(a) A chemical that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Hood A device/location in a laboratory, enclosed on five sides, to draw air from the laboratory and to prevent or minimize the escape of the air contaminants into the laboratory. Chemical manipulations may be conducted in the enclosure without inserting any portion of the employee's body other than hands and arms.

Infectious Waste that is capable of producing disease. For waste to be considered infectious,

Waste	it must contain oncogenic viruses or other pathogenic microorganisms with sufficient virulence and quantity that exposure to the waste could result in an infectious disease.
Irritant	Chemical substances that cause tissue inflammation or soreness upon absorption, inhalation, or ingestion.
JKKP	Jabatan Keselamatan dan Kesihatan Pekerjaan, Wilayah Persekutuan - the Federal Territory agency charged with worker health and safety. JKKP promulgates occupational safety and health standards.
LD_{50}	The quantity of material that when ingested, injected, or applied to the skin as a single dose, will cause death of 50% of the test animals. The test conditions should be specified, the value is expressed in g/kg or mg/kg of body weight.
LEL	Lower Explosive Limit - same definition as LFL.
LFL	Lower Flammable Limit - The lower limit of flammability of a gas or vapor at ordinary ambient temperatures expressed in percent of the gas or vapor air by volume. This limit is assumed constant for temperatures up to 250°F (120C°) and is normally listed on a product's material safety data sheet.
LS	Laboratory Supervisor
NRE	Ministry of Natural Resources and Environment **(NRE)** federally regulates and enforces environmental protection.
MSDS	Material Safety Data Sheets are produced by chemical manufacturers and importers. They relay chemical, physical, and hazard information about specific chemicals.
Mutagen	Chemical compounds that induce mutations in DNA and living cells.
Neutralize	To alter acidic or basic compounds to a pH of 7, making it chemically neutral.
Organic Materials	Any chemical compound containing carbon.
OSHA	Occupational Safety and Health Administration - the local branch agency charged with worker health and safety is the **JKKP, Wilayah Persekutuan**.
Oxidizer	A chemical that initiates or promotes combustion in materials, thereby causing fire either of itself or by the release of oxygen or other gases.
Oxidizing Agent	Oxygen-containing material which can decompose, generating oxygen.
PEL	Permissible Exposure Limits for the work place, set by regulation and enforced by OSHA. Most of these limit values were originally set, by consensus, by the ACGIH to assist industrial hygienists in implementing exposure control programs.
PI	Principal Investigator
Poison	Any substance which is harmful to living tissue when applied in small doses. Determining factors include concentration, exposure time, particle size, the substance's affinity for tissue, and sensitivity of the exposed tissue to that compound.
Pyrophoric Material	Any solid or liquid that has the property of spontaneous ignition in air.
Reactivity	The proclivity of a compound to chemically react with other substances or itself, resulting in the liberation of energy. Can cause the formation of toxic or corrosive materials, pressure buildup, and temperature fluctuations.
Reproductive Toxins	Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).
Sensitizer	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.
STEL	Short Term Exposure Limit, a 15-minute time-weighted average exposure which should not be exceeded at any time during a work day, even if the eight-hour time-weighted average is within the TLV.
Teratogen	Chemical and physical agents which interfere with normal embryonic development. Teratogens may produce congenital malformations or death of the fetus without inducing damage to the pregnant female.

TLV Threshold Limit Value indicates the concentration of a chemical substance in the atmosphere that is considered non-hazardous in a person's normal working life.

TWA Time Weighted Average is the concentration for a normal 8-hour working day (40 hours/week) to which workers may be exposed without anticipated adverse effect.

Toxic A chemical falling within any of the following categories:

(a) A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

(b) A chemical that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

(c) A chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Ultraviolet Light Radiation in the electromagnetic spectrum with wavelengths of 100 - 3900 Ångstroms.

Volatility The tendency of a liquid or solid to pass into the vapor state at a particular temperature.

Water Reactive A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Appendix VII

SAFETY CHECKLIST FOR LABORATORY USERS

Please read the following questions and think carefully about your answers.

YES / NO

1. Do you wash your hands before leaving the laboratory?
2. Do you wear appropriate attire in the laboratory (lab coat, safety goggles, gloves, shoes)?
3. Are the appropriate hazard signs and emergency numbers displayed in the laboratory?
4. Are all containers in your laboratory properly labeled? Do you know how to interpret these labels?
5. Do you know where to find Material Safety Data Sheets (MSDSs) for all chemicals used in your laboratory?
6. Are the chemicals in your laboratory properly stored?
7. Have you been instructed in the proper use and handling of the chemicals in your laboratory?
8. Have you been instructed in the location and use of safety devices (safety showers, eyewashes, laboratory hoods, etc.) in your laboratory?
9. Are you aware of emergency procedures in the event of a chemical exposure, spill, fire or explosion?
10. Do you know how to properly segregate and dispose of chemicals you will use?
11. Are all mechanical engineering controls (e.g., fume hoods) operating properly?
12. Do you know who to notify if working in a laboratory alone after normal hours?
13. Have you attended laboratory specific training provided by your Laboratory Supervisor?
14. Do you know where your laboratory Standard Operating Procedures (SOP) are stored and have you read them?
15. Are you familiar with the experiment protocol you are following? Do you feel confident in performing the procedure without additional information or demonstration?

If you answered NO to any of these questions, read this laboratory safety guide and if you still have questions, see your laboratory supervisor.

Appendix VIII

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