LABORATORY SAFETY MANUAL
Revised March 2004

It is our intention to provide and maintain a safe working environment for all employees of the University through the dissemination of information, provision of training, enforcement of procedures and the monitoring and evaluation of performance. The purpose of the Laboratory Safety manual is to provide guidelines for prudent work practices and procedures in the laboratory and in so doing protect workers from potential health and safety hazards they may encounter in the work place. All laboratory users must be made aware of this manual, understand its contents and as much as possible, exceed its recommendations. This manual should be easily accessible and available at all times.

1.1 Preparing for Laboratory Works

Before starting to work in a laboratory, familiarize yourself with the following:

• Job Safety Analysis (JSA) indicating the hazards of the materials in the lab, as well as appropriate safe handling, storage and emergency protocols. Read labels and material safety data sheets (MSDS's) before moving, handling or opening chemicals. Never use a product from an unlabeled container, and report missing labels to your supervisor.
• The agents, processes and equipment in the laboratory. If you are unsure of any aspect of a procedure, check with your supervisor before proceeding.
• The location and operation of safety and emergency equipment such as fire extinguishers, eyewash and shower, first aid and spill response kits, fire alarm pull stations, telephone, emergency numbers and emergency exits.
• Emergency spill response procedure for the material you will handle
• Emergency reporting procedures and telephone numbers.
• Designated and alternate escape routes.
• Any student / employee who has a disability and the precautions necessary.

1.2 DURING LABORATORY WORKS

• Restrict laboratory access to authorized persons only.
• Do not permit smoking, eating, drinking, storing food, beverages or tobacco, applying cosmetics or lip balm and handling contact lenses in laboratories.
• Wear labs coats (knee length) and safety glasses in laboratories. Open shoes, such as sandals, should never be worn in the lab.
• Tie back or other wise restrain long hair when working with chemicals, biohazards, radioisotopes, or moving machinery.
• Keep work places clean and free of unwanted chemicals, biological specimens, radioactive material and idle equipment. Avoid leaving reagent bottles empty or full, on the floor.
• Work only with materials that you know their flammability, reactivity, toxicity, safe handling and storage and emergency procedures.

• Never pipette by mouth, use mechanical transfer devices.
• Walks, do not run in the lab particularly if you've are carrying any hazardous material.
• Keep exits and passageways clear at all times.
• Ensure that access to emergency equipment (eyewashes, safety shower and fire extinguishers) is not blocked.
• Working alone is an unsafe practice at any time. However, if the nature of the work makes it unavoidable, take measures to ensure that others are aware of your location and have someone check in with you from time to time, either in person or by telephone. Additionally, if you are working outside normal working hours, please obtain the necessary approval and inform security of your whereabouts.
• Report accidents and dangerous incidents ("near-misses") promptly to your supervisor and the safety officer. Complete the prescribed form
• Wash your hands thoroughly before leaving the laboratory.
• Any procedures involving the release of volatile toxic or flammable materials should be conducted in a chemical fume hood.
• Perform procedures that release infectious bio-aerosols in a biological safety cabinet
• Handle all human blood and body fluids as if potentially infectious. Universal Rule.

1.3 CLEANING UP BEFORE LEAVING THE LABORATORY

Perform a safety check at the end of each experiment and before leaving the labs. Make sure to:

• Turn off gas, water, electricity, vacuum and compression lines and any heating apparatus
• Return unused materials, equipment and apparatus to their proper storage locations
• Label, package and dispose of all waste material properly and promptly.
• Remove defective or damaged equipment immediately, and arrange to have it repaired or replaced
• Decontaminate any equipment or work areas that may have been in contact with hazardous materials
• Leave behind protective clothing (lab coats, gloves, etc.) when leaving the laboratory.
• Close and lock the door to the laboratory if you are the last one to leave.

1.4 EVALUATING LABORATORY HAZARDS AN ONGOING PROGRESS

There are many categories of hazards that might be encountered in a laboratory setting, and the situation can change frequently. Even after you have identified and controlled all current risk, it is critical that you remain open to the possibility that new unexpected dangers can arise. Carry out regular inspections on the condition of:

• Fire extinguishers (Safety Officer)
• Emergency eyewashes and Showers. Run these for several minutes weekly (Quarterly checks by Safety Officer)

• First aid kit. Contents must relevant to the risk of the laboratory.
• Fume hood and other ventilation devices. Annual certification required.
• Any tubing / piping for circulating water, vacuum, gases
• Chemical storage compartments. Ensure compatibility.
• Ensure that fire extinguishers and emergency showers are inspected, tested recorded.

Among potential laboratory hazards, be alert for the following:

• Chemicals
- Flammable
- Toxic
- Oxidizing
- Reactive
- Corrosive

• Microbiological disease-producing agents and their toxins
- Viruses
- Bacteria
- Parasites
- Rickettsiae
- Fungi

• Physical or mechanical hazards
- Ionizing and non-ionizing radiation
- Electrical and other energy sources
- Poor equipment design or work organization (ergonomic hazards)
- Tripping hazards
- Excessive noise or heat
• Psychosocial conditions that can cause psychological stress.

2.1 LABELS, MATERIAL SAFETY DATA SHEETS, TRAINING

Labels or hazardous material information must alert people to the dangers of the product and basic safety precautions. Please ensure that it is intact on the containers. Replace and re-label as necessary.

MSDS's provide more details then the labels. There are technical bulletins that provide chemical, physical, and toxicological information about each controlled product, as well as information on precautionary and emergency producers. They must be readily accessible to anyone who work with, or who may other wise be exposed to, controlled

products. Please lodge a hard copy of all chemicals used in the lab in an easily accessible area. (See Chemical Hygiene Plan)

Training provides more detailed instruction on the specific procedures necessary to carry out safely. Basic training, referred to as core training, provides instruction on the content, propose and interpretation of information found on labels and in MSDSs for controlled products.

Hazard-specific or job-specific training refers to instruction in the procedures for the safe handling and storage of the controlled products that are unique to each laboratory. Hazard-specific training also covers spill or leak remediation, waste disposal basic first aid instructions and is critical to the proper functioning of any lab. The Safety Officer will organize general training. However the immediate supervisor of each lab should carry specific job training.

2.2.2 TOXICOLOGICAL PROPERITIES: LD50 AND LC50:

Despite the limitations of using toxicity data from animal studies to predict the effects on humans, LD50 and LC50 values often comprise a large part of the available toxicity information, and form the bases for many standards, guidelines and regulations.

LD50 (Lethal Dose50) is the amount of a substance that, when administered by a define route of entry (e.g. oral or dermal) over a specified period of time, is expected to cause the death of 50 per cent of a defined animal population. The LD50 is usually expressed as milligrams or grams of test substance per kilogram of animal body weight (mg/kg or g/kg).

LC50 (Lethal Concentration50) is the amount of substance in the air that, when given by inhalation over a specified period of time, is expected to cause the death in 50 per cent of a defined animal population. Some LC50 values are determined by administration of test substances to aquatic life in water.

LC50 is expressed as parts of test substance per million parts of air (PPM) for gases and vapors, or as milligrams per litre or cubic metre of air (mg/L or mg/m3) for dusts, mists and fumes.

When assessing the hazards of materials used in the laboratory, it is important to remember that substances with lower LD50 or LC50 values are more toxic that those with higher values.

2.2.3 EXPOSURE LIMITS (TLV)

An exposure limit is the maximum limit of exposure to an air contaminant. The threshold limit value (TLV) or permissible exposure limit (PEL) can be expressed as the following:

• 8-hour time-weighted average (TWA) is the average concentration to which most workers can be exposed during an 8-hour workday, everyday, without harmful effects.
• Short-term exposure limit (STEL), is the maximum average concentration to which most workers can be exposed over a 15 minute period, everyday, without adverse effects
• Ceiling (C) defines a concentration that must never be exceeded and is applied to many chemicals with acute toxic effects.

It should be noted that most exposure limits are based on industrial experiences and not entirely relevant to the laboratory environment. Good laboratory practices and well-designed ventilation systems serve to maintain air concentrations well below these limits.

2.2.4 FLASH POINT

The flash point is the lowest temperature at which a liquid produces enough vapour to ignite in the presence of a source of ignition. The lower the flash point, the greater the risk of fire. Many common laboratory solvents (e.g., acetone, benzene, diethyl ether, methanol) have flash points that are below room temperature.

2.2.5 AUTOIGNITION TEMPERATURE

The ignition or autoignition temperature is the temperature at which a material will ignite, even in the absence of an ignition source, a spark is not necessary for ignition when a flammable vapour reaches its autoignition temperature. The lower the ignition temperature, the greater the potential for a fire started by typical laboratory equipment.

2.2.6 FLAMMABLE LIMITS

Flammable limits or explosive limits define the range of concentrations of a material in air that will burn or explode in the presence of an ignition source such as a spark or flame. Explosive limits are usually expressed as the percent by volume of the material in air.

• The lower explosive limit (LEL) or lower flammable limit (LFL) is the lowest vapor concentration that will burn or explode if ignited. Below this limit, the concentration of fuel is too “lean” for ignition, i.e., the mixture is oxygen rich but contains insufficient fuel.
• The upper explosive limit (UEL) or upper flammable limit (UFL) is the highest vapour concentration that will ignite. Above this limit, the mixture is too “rich” for ignition.
• The flammable range consists of concentrations between the LEL and UEL

Table list flash points, lower explosive limits and exposure limits (8-hour time-weighted averages) of several flammable or combustible laboratory solvents.

Solvent FPL
(oC) LEL (% by volume) Autoignition Temperature TLV – TWA * ppm (mg/m3)
Acetic acid, glacial
39
4.0
427
10 (25)
Acetone -18 2.5 538 250 (590)
Acetonitrile 5.6 3.0 524 20 (34)
Diethyl ether -45 1.9 180 400 (1210)**
Ethanol, absolute 13 3.3 423 1000 (1900)
Ethyl acetate -4.4 2.0 427 400 (1440)
Methanol 11 6.0 464 200 (260)
N-pentane -49 1.5 309 120 (350)
Toluene 4.4 1.1 552 100 (375)

3. CONTROL OF CHEMICAL HAZARDS

3.1 TOXIC CHEMICALS AND THE FOUR ROUTES OF ENTRY

Chemicals can gain entry into the body by:

• Inhalation of gases, vapours and particular material (e.g. mists, dusts, smokes, fumes)
• Absorption through skin - liquids, solids, gases and vapours.
• Ingestion of chemical directly via contaminated foods and beverages and contact between mouth and contaminated hands (nail-biting, smoking)
• Injection of chemicals through needles and other contaminated laboratory sharps

3.2 FLAMMABEL CHEMICALS

Flammable and combustible liquids, solids or gases will ignite when exposed to heat, sparks or flame. Flammable material burns readily at room temperature, while combustible material must be heated before they will be burn. Flammable liquids or their vapours are the most common fire hazards in laboratories. Section 5.4 (“Preventing Fires”) gives specific details on the safe handling of flammable chemical in the laboratory.

3.3 OXIDIZING CHEMICALS

Oxidizers provide oxidizing elements such as oxygen or chlorine and are capable of igniting flammable and combustible material even in an oxygen-deficient atmosphere (See Section 5.1, “The Fire Triangle”). Oxidizing chemicals can increase the speed and intensity of fire by adding to the oxygen supply, causing materials that would normally not burn rapidly. Oxidizers can also:

- React with other chemicals, resulting in release of toxic gases
- Decompose and liberate toxic gases when heated
- Burn or irritate skin, eyes, breathing passages and other tissues

Precautions to follow when using and storing oxidizer in the laboratory include the following:

- Keep away from flammable and combustible materials
- Keep container tightly closed unless otherwise indicated by the supplier
- Mix and dilute according to the supplier’s instructions
- To prevent release of corrosive dusts, purchase in liquid instead of dry form
- Reduce reactivity of solutions by diluting with water
- Wear appropriate skin and eye protection
- Ensure that oxidizers are compatible with other oxidizer in the same storage area

3.4 REACTIVE CHEMICALS

- May be sensitive to jarring, compression, heat or light
- May react dangerously with water or air
- May burn, explode or yield flammable or toxic gases when mixed with incompatible materials
- Can vigorously decompose, polymerize or condense
- Can also be toxic, corrosive, oxidizing or flammable
- Some chemicals may not be dangerous when purchased but may develop hazardous properties over time (e.g. diethyl ether and solution of picric acid).

Follow these precautions when working with dangerously reactive chemicals:

• Understand the hazards associated with these chemicals and use them under conditions, which keep them stable. Consult MSDS
• Store and handle away from incompatible chemicals
• Keep water-reactive chemicals away from potential contract with water, such as plumbing, fire sprinkler heads and water baths
• Handle in a chemical fume hood
• Wear the appropriate skin and eye protection
• Work with small quantities
• Use up or dispose of these chemicals before they attain expiry date

3.5 CORROSIVE CHEMICALS

Corrosive are materials, such as acids and bases (caustics, alkalis), which can damage body tissues as a result of splashing, inhalation or ingestion. They can also:

• Damage metals, releasing flammable hydrogen gas
• Damage some plastics
• Some corrosives, such as sulphuric, nitric and perchloric acids, are also oxidizers, thus they are incompatible with flammable or combustible material
• Release toxic or explosive products when reacted with other chemicals
• Release heat when mixed with water

Precautions for handling corrosive materials include:

• Wear appropriate skin and eye protection
• Use in the weakest concentration possible
• Handle in chemical fume hood
• Use secondary containers when transporting and storing corrosives
• Always dilute by adding acids to water
• Dilute and mix slowly
• Store acids separately from gases

3.6 HAZARDOUS CHEMICAL SPILLS

3.6.1 SPILL REPONSE CONTINGENCIES

Laboratory heads are responsible for predetermining procedures for response to the type of spill situations that may be anticipated for their operations and for putting systems in place. Individuals requiring assistance in preparing spill response plans should contact the Safety Officer (3138). All spills should be reported to the immediate supervisor and the safety officer.

In instances where more extensive equipment or technical assistance is needed, backup can be provided by other faculties /departments as well as competent external sources.

3.6.2 DEVELOPMENT OF SPILL RESPONSE PLANS

3.6.2.1 COMMUNICATIONS

All laboratories housing hazardous materials are required to have means of reaching external sources that may be mobilized in the event of emergencies involving their laboratory, especially for after-hours situations. This may involve posting the relevant telephone number(s) and providing them to the Security Services, who provided 24 hr coverage. The onus is on the person/persons in charge of the laboratory to ensure that this is put in place. The head of the department has the responsibility to provide the necessary resources to accomplish this.

3.6.2.2 GENERAL GUIDELINES

The following factors are to be considered when developing spill response procedures:

• Categories of chemicals (e.g. oxidizers, flammable solvents) and their chemical, physical and toxicological properties.
• The quantities that may be released.
• Possible locations of release (e.g. Laboratory, corridor).
• Personal protective equipment needed. Ensure that you have these.
• Types and quantities of neutralizing or absorbing material needed. Must be easily accessible.

These guidelines should be followed when initially responding to spill situation:

• Determine appropriate clean up method by referring to the Material Safety Data Sheet (MSDS). If you are unsure how to proceed, or if you do not have the necessary protective equipment, do not attempt to clean up the spill.
• If the spill is minor and of known limited danger, clean up immediately.
• If the spill is of unknown composition, or potentially dangerous (explosive, toxic vapours), alert everyone present and evacuate the area.
• If the spill cannot be safely handled using the equipment and personnel present, call the emergency telephone number (Ext. 3138, Safety Officer, Security 2120) to request assistance.
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3.6.3 GUIDELINES FOR SPECIFIC TYPE OF SPILLS

3.6.3.1 FLAMMABLE AND TOXIC LIQUIDS

• If you can do so without putting yourself at risk, immediately shut off all potential ignition sources
• If fire occurs, alert everyone present and extinguish all flames. If the fire cannot be controlled immediately pull the nearest fire alarm or raise an alarm.
• If no flames are evident, pour adsorbent around the perimeter of the spill and then cover the rest of the material. Wear an appropriate respirator if the toxic vapours are involved.

• Wear gloves resistant to the chemical being handled. Using a plastic utensil (to avoid creating sparks), scoop up the absorbed spill, place it in a plastic bag, seal it and place in a labeled container.
• Ensure that you have the items mentioned above in your laboratory.

3.6.3.2 CORROSIVE LIQUIDS

• Alert everyone present. If vapours are being released, clear the area.
• Do not attempt to wipe up a corrosive liquid unless it is very dilute.
• Gloves, boots, apron and eye protection must be used when neutralization an extensive corrosive spill. Respiratory protection is required if the liquid releases corrosive vapour or gas.
• Pour the required neutralizing or absorbing material around the perimeter of the spill, then carefully add water and more neutralizing material to the contaminated area. Carefully agitate to promote neutralizing.
• Use pH paper to verify that all contaminated areas are neutralized and safe to wipe up.
• If an adsorbent (e.g. spill control pillows) is used instead of a neutralizer, scoop up the absorbed spill, place in a plastic bag, and then place in a labeled box. If neutralized material contains no toxic heavy metals (e.g. chromium) flush down the drain with plenty of water.

3.6.3.3 CORROSIVE SOLIDS

Small spills can be cleaned up mechanically with a dustpan and brush. Larger spills should be cleaned up using a HEPA (high-efficiency particulate) filter vacuum. For spills containing fine dusts, an air-purifying respirator with dust filters is recommended, as are gloves, protection goggles, and a lab coat.

3.6.3.4 TOXIC SOLIDS

Avoid disturbing such solids (e.g. asbestos), which may release toxic dusts. Wet the material thoroughly, then place it in a plastic bag and label it appropriately. If wet removal is not possible, a vacuum equipped with a HEPA (High Efficiency Particulate Air) filter is required.

3.6.3.5 GASES

In the event of the release of a corrosive gas (e.g. chlorine) or any that may be absorbed through the skin (e.g. hydrogen cyanide), a complete chemical resistant suit and self-contained breathing apparatus are required. There are no practical means of absorbing or neutralizing a gas – the leak must be corrected at the source.

3.6.3.6 MERCURY

If a small amount of mercury is spilled (e.g. broken thermometer), use an aspirator bulb or mercury sponge to pick up droplets, place the mercury in a container, cover with water, seal it, and label the bottle appropriately. To clean up the residual micro-droplets that may have worked into cracks and other hard-to-clean area, sprinkle sulphur power or other commercially available product for mercury decontamination. Leave the material for several hours and sweep up solid into a plastic bag, seal it and label it appropriately. Appropriate respirator must be worn.

4 HANDLING AND STORAGE OF LABORATORY CHEMICALS

4.1 GENERAL GUIDELINES

Guidelines for storage of hazardous chemicals
Store hazardous chemicals in an area that is accessible only to authorized laboratory workers only.

• Segregate chemicals according to reactivity and flammability.
• Minimize quantities and container size kept in laboratories.
• Keep glass containers off the floor, away from possible collisions with people and equipment
• Store chemicals away from sources of heat and direct sunlight
• Store containers of liquids inside secondary containers (such as trays or tubs) that are large enough to hold spills
• Do not store hazardous liquids or large objects on shelves above eye level
• Install edge guards on all open shelves used for storage of chemicals
• Use sturdy shelves with a load capacity that exceeds that of the chemicals stored on them. Regularly inspect clamps, supports, shelf brackets and other shelving material.
• Maintain labels. Check storage areas weekly for faded, missing or loose labels and replace.
• Dispose of unwanted chemicals promptly
• Keep inventory records of chemicals as well as MSDS hard copies of all chemicals used in the laboratory.

4.2 FLAMMABLE LIQUID STORAGE CABINETS

Flammable chemicals should be stored inside flammable liquid storage cabinets. Only those flammable in use for the day should be outside the cabinet. Guidelines for cabinet use include:

• Use NFPA or UL approve flammable liquid storage cabinets
• Keep cabinet door of the cabinet closed and locked
• Do not store other materials in these cabinets

4.3 CHEMICAL COMPATIBILTY

The storage scheme outline in ("Chemical Segregation") may not be adequate to prevent mixing of incompatible chemicals. Certain hazardous combinations can occur even between chemicals of the same classifications. Please obtain all relevant information if you are uncertain. The table below shows common examples of incompatible combinations:

Example of incompatible combinations of some commonly used chemicals.

CHEMICAL KEEP OUT OF CONTACT WITH:
Acetic Acid Chromic acid, nitric acid, hydroxyl compounds, perchloric acid, peroxides, permanganate
Acetylene Chlorine, bromine, copper, fluorine, silver, mercury
Alkali Metal (e.g. Sodium) Water, chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia, Anhydrous Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammoniun Nitrate Acids, metal powers, flammable liquids, chlorates, nitrites, sulphur, finely divided combustible materials.
Aniline Nitric acid, hydrogen peroxide
Bromine Same as chlorine
Carbon, Activated Calcium hypochlorite, all oxidizing agents
Chlorates Ammonium salts, acids, metal powers, sulphur, finely divided combustible materials
Chromic Acid Acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol, flammable liquids.
Chlorine Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Copper Acetylene, hydrogen peroxide
Flammable Liquids Ammonium nitrate, inorganic acids, hydrogen peroxide, sodium peroxide, halogens
Hydrocarbons Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydroflouric Acid Anhydrous ammonia, ammonium hydroxide
Hydrogen Peroxide Copper, chromium, iron, most metals or their salts, alcohols, acetone, aniline, nitromethane, flammable liquids, oxidizing gases
Hydrogen Sulphide Fuming nitric acid, oxidizing gases
Iodine Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury Acetylene, fulminic acid, ammonia
Nitric Acid Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids, flammable gases
Oxalic Acid Silver, mercury
Perchloric Acid Acetic anhydride, bismuth and its alloys, organic materials
Potassium Carbon tetrachloride, carbon dioxide, water
Potassium Chlorate Sulphuric and other acids
Potassium Permanganate Glycerin, ethylene glycol, benzaldehyde, sulphuric acid
Silver Acetylene, oxalic acid, tartaric cid, ammonia compounds

Sodium Peroxide Alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulphide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulphuric Acid Potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc.)

4.4 CHEMICAL SEGREGATION

• Read the label carefully before storing a chemical. More detailed storage information is usually provided by the MSDS (Material Safety Data Sheet).
• Ensure that incompatible chemicals are not stored in close proximity to each other. Separate the following types of chemicals from each other according to the segregation scheme in the table above. Remember that this is a simplified table and in some instances chemicals of the same category may be incompatible.

For more detailed information refer to the reactivity section of the Material Safety Data Sheet or a reference manual on reactive chemical hazards.

Table 4 suggested Segregation for Chemical Storage.

FLAMMABLES NON-FLAMMABLE SOLVENTS ACIDS
• Store in grounded flammable liquid storage cabinet
• Separate from oxidizing materials

Example:

• Acetone
• Ethanol Glacial acetic acid
• Store in cabinet
• Can de stored with flammable liquids
• Separate from oxidizing material

Examples:

• Carbon tetrachloride
• Ethylene glycol Mineral oil • Store in cabinet of non-combustible material
• Separate oxidizing acids from organic acids
• Separate from caustics, cyanides, sulfides

Example

• Nitric acid
• Hydrochloric acid Sulphuric acid

CAUSTIC WATER REACTIVE CHEMICLS OXIDIZERS

• Store in dry area
• Separate from acids

Example

• Ammonium hydroxide
• Sodium hydroxide
• Potassium hydroxide • Store in cool, dry location
• Separate from aqueous solutions
• Protect from fire sprinkler water

Examples:

• Sodium
• Potassium Lithium • Store in cabinet of non-combustible material
• Separate from flammable and combustible materials

Examples:

• Sodium hypochlorite
• Benzoyl peroxide Potassium permanganate
NON-OXIDIZING COMPRESSED GASES OXIDIZING COMPREESSED GASES
NON-VOLATILE, NON-REACTIVE SOILDS
• Store in well ventilated area
• Separate physically from oxidizing compressed gases

Example

• Nitrogen
• Hydrogen Carbon Dioxide
• Separate physically from flammable compressed gases

Examples:

• Oxygen
• Chlorine Nitrous oxide
• Store in cabinets or open shelves with edge guards

Examples:

• Agar
• Sodium Chloride Sodium Bicarbonate

4.5 UNSTABLE CHEMICALS

Many chemicals, most notably ethers (e.g., THF, dioxane, diethyl and isopropyl ether), are susceptible to decomposition resulting in explosive products. Ethers, liquid paraffins, and olefins form peroxides on exposure to air and light. Since most of these products have been packaged in an air atmosphere, peroxides can be form even if the containers have not been opened.

• Discard unopened containers of ethers after one year
• Discard containers of ethers within six months of opening
• Never handle ethers beyond their expiry dates, contact your local waste disposal coordinator to arrange to have the material stabilized and removed

The following are common examples of compounds prone to peroxide formation:
• Cyclohexene • dioxane
• Dicyclopentadiene • Isopropyl ether
• Diethyl ether (ether) • Tertrahydrofuran (THF)
• Dimethyl ether

• The label and Material Safety Data Sheet (MSDS) will also indicate if chemical is unstable.

4.6 EXPLOSIVE CHEMICALS

Many chemicals are susceptible to rapid decomposition or explosion when subjected to forces such as being struck, vibrated, agitated or heated. Some become increasingly shock sensitive with age.

• Refer to the label and the Material Safety Data Sheet to determine if a chemical is explosive.

• Write the date received and opened (this applies to all chemicals as well) on all containers of explosive or shock-sensitive chemicals
• Discard open containers after six months, and closed containers after one year.
• Wear appropriate personal protective equipment and perform experiments behind face shield.
• Work with small quantities.
• The following are atomic groupings that are associated with possibility of explosion:
-acetylide -fulminate -nitrose
-amine oxide -N-haloamine -nitro
-azide -hypohalite -ozonide
-chlorate -hydroperoxide -perchlorate
-diazo -nitrate -peroxide
-diazonium -nitrite -picrate

• The following are common examples of materials known to be shock-sensitive and explosive:

-ammonium nitrate -lead azide
-ammonium perchlorate -nitroglycerine
-copper acetylide -picric acid (when dry)
-dinitrotoluene -trinitroluene
-fulminate of mercury

5 FIRE SAFETY

Laboratory fires can be caused by bunsen burners, runaway chemical reaction, electrical heating unit, failure of unattended or defective equipment, or overloaded electrical circuits. Familiarize yourself with the operation of the fire extinguishers and the location of the pull stations, emergency exits and evacuation routes where you work. In the event that the general alarm is sounded use the evacuation routes established for your area and follow the instructions of Wardens and Monitors. Once outside of the building, move away from the doors to enable others to exit and proceed to the emergency assembly point.

5.1 THE FIRE TRIANGLE

Fire cannot occur without an ignition source, fuel and oxidizing atmosphere (usually air), the three elements that comprise what is called the “fire triangle”.
Fire will not be initiated if any if any one of these elements is absent, and will not be sustained if one of these elements is removed. This concept is useful in understanding prevention and control of fires. For example, the coexistence of flammable vapours and ignition sources should be avoided, but when flammable vapours cannot be controlled elimination of ignition sources is essential.

5.2 CLASSES OF FIRE

The National Fire Protection Association (NFPA) has defined four classes of fire, according to the type of fuel involved. These are:

• Class A fires involve combustibles such as paper, wood, cloth, rubber and many plastics.
• Class B fires entail burning of liquid fuels/ hydrocarbons like oil-based paints, greases, solvents, oil and gasoline.
• Class C fires are of electrical origin (fuse boxes, electric motors, wiring).
• Class D fires encompass combustible metals such as magnesium, sodium, potassium and phosphorus.

5.3 FIRE EXTINGUISHERS

Fire extinguishers are rated as A, B, C, or D (or combinations of A, B, C, and D) for use against the different classes of fires. Familiarize yourself with the fire class ratings of the extinguishers in your work area so that you will know what types of fire you can attempt to extinguish with them. Learn how to use the extinguisher in your lab, as there will be no time to read instructions during an emergency. Attempt to fight small fires only, and only if there is an escape route behind you. Remember to have the extinguisher recharged after every use. Contact the safety officer at ext. 3138 if a fire extinguisher is to be recharged. If you do fight a fire, remember the acronym “PASS” when using the extinguisher:

• P: Pull and twist the lock pin to break the seal.
• A: Aim low, and point the nozzle at the base of the fire.
• S: Squeeze the handle to release the extinguishing agent.
• S: Sweep from side to side until the fire is out.

Some Key Points

• Be prepared to repeat the process if the fire breaks out again.
• Never turn your back on a fire
• Always stand upwind of a fire
• Obtain training.

5.4 PREVENTING FIRES

Use the following precautions when working with or using flammable chemicals in a laboratory, keep in mind that these precautions also apply to flammable chemical waste.

• Minimize the quantities of flammable liquids kept in the laboratory. Do not exceed the limits established by the National Fire Protection Association (NFPA).

• Except for the quantities needed for the work at hand, keep all flammable liquids in approved flammable liquid storage cabinets. Keep cabinet doors closed and locked at all times. Do not store other materials in these cabinets.
• Use and store flammable liquids and gases only in well ventilated are areas. Use a fume hood when working with products that release flammable vapours.
• Keep flammable solvent containers, including those for collecting waste, well capped.
• Store flammable chemicals that require refrigeration in “explosion-safe” (non-sparking) laboratory refrigerators.
• Keep flammable chemicals away from ignition sources, such as heat, sparks, flames and direct sunlight as well as other energy sources. Avoid welding or soldering in the vicinity of flammables.
• Bond and ground large metal containers of flammable liquids in storage. To avoid the build-up of static charges, bond containers to each other when dispensing.
• Use portable safety cans for storing, dispensing and transporting flammable liquids.
• Clean spill of flammable liquids promptly.

5.5 EVACUATIONS

In the event that the general or any alarm is sounded, follow the evacuation routes established for your area, do not use the elevators. Follow the instructions of the Wardens and Monitors. Once outside the building, move away from the door to allow others to exit and go to the emergency assembly point. See emergency evacuatiom

6 HAZARDOUS WASTE DISPOSAL

6.1 WASTE MINIMIZATION

In order to minimize the amount of hazardous waste presented for disposal, it is important to follow these guidelines:

• Avoid overstocking: one of the main sources of laboratory waste is surplus stock – the result of over buying. Some suppliers have offered benefits for purchasing chemicals in large volumes.
• Do not accept donations of materials that you don’t plan to use. Many organizations have traditionally unloaded unwanted reagents by donating them to laboratories, which eventually transfers the cost of disposal of the University.
• Substitute non-hazardous experimental materials for hazardous ones. For example, use aqueous-based, biodegradable scintillation fluids whenever possible.
• Communicate with other departments. Far to often departments buy chemicals only to use very little for an experiment that would be repeated next four years or maybe never again. The rest ends up in stores or on a laboratory shelf. Duplicate buying should be avoided. Please contact the safety officer for assistance.

6.2 HAZARDOUS WASTE DISPOSAL GUILDLINES

• Label all waste materials completely and legibly. Inadequately labeled containers will not be accepted.
• Package waste materials in approved containers.
• Over filled and or leaking containers cannot be accepted for disposal.
• Never discharge waste into the sewer unless you have verified that hazardous waste regulations permit you to do so. For information, contact Solid Waste Co. Ltd
• Complete the prescribed form and submit to the safety officer who would coordinate disposal on campus.

6.3 WASTE PREPARATION PROCEDURES

6.3.1 CHEMICAL WASTE

6.3.1.1 ORGANIC SOLVENTS AND OILS

• Obtain appropriate containers.
• Indicate the composition of the contents as accurately as possible on the prescribed form.
• Contact the Safety officer at ext 3138
•

6.3.1.2 MISCELLANEOUS CHEMICAL AND GAS CYLINDERS

• Complete the prescribed form and send to Safety Officer.
• Await instruction

6.3.1.3 CHEMICALS OF UNKNOWN COMPOSITION

• Cannot be accepted
• Analyze or contact the safety officer to arrange for analysis (at the expense of the waste generator)

6.3.1.4 PEROXIDE-FORMING CHEMICALS (E.G. ETHER) AND EXPLOSIVE CHEMICALS (E.G. DRY PICRIC ACID)

• Do not mix with solvents or other waste.
• If the material is older than one year, do not attempt to open or remove the container. Contact safety officer for advice.

6.3.1.5 CORRISIVE (ACIDS AND BASES)

• Collect acids (pH<7) and bases (pH>7) separately in the plastic containers Do not mix acids with bases.

• Indicate the composition of the contents, as accurately as possible, on the prescribed form.

6.3.2 BIOMEDICAL WASTE

6.3.2.2 INFECTIOUS LABORATORY WASTE

• Place in the plastic-lined biomedical containers

6.3.2.3 BIOHAZARDOUS SHARPS (SYRINGES, SCALPEL BLADES, PASTEUR AND SEROLOGY PIPETTES)

6.3.2.4 BLOOD AND BLOOD-CONTAMINATED MATERIALS

• Blood can be disposed via the drains. Designate one sink for this purpose and run water into it regularly after discharging blood.
• After discharging blood, decontaminated the sink with sodium hypochlorite solution.
• Dispose of blood-contaminated materials as infectious waste.

6.3.3 SHARPS AND GLASSWARE

6.3.3.1 SYRINGES, SCAPEL BLABES, PASTUER AND SEROLOGY PIPETTES, CAPILLARY TUBES, ETC.

6.3.3.1.1 CONTAMINATED SHARPS

• Never recap or syringe needles.
• Label a plastic, puncture proof container (e.g. empty liquid bleach bottle) with the word “SHARPS”, the appropriate hazard warning symbol (e.g. biohazard, radioactive)
• Discard containers of sharps contaminated with infectious materials into biomedical waste containers as per the producer for infectious Laboratory Waste.
• Discard containers of sharps contamination with radioactive materials as per the procedure for solid radioactive waste.

6.3.3.1.2
NON-CONTAMINATED SHARPS

• Label a puncture-proof container (wide-mouth plastic bottle or a heavy-duty cardboard box lined with plastic) with the “SHARPS’.
• Accumulate in the designated container.
• When full, close and seal the container and place it beside the regular garbage receptacle for pickup by the cleaning staff.

6.3.3.2 BROKEN GLASSES (NON-CONTIMAINATED)

• Designate a cardboard box for broken glass, label it “BROKEN GLASS”, and place glass inside. When the box is full, seal it with tape and place it next to the garbage receptacle for pickup by cleaning staff.

6.3.3.3 EMPTY CHEMICAL REAGENT BOTTLES

• Remove the cap from the empty bottle and allow volatile materials to evaporate into fume hood.
• Rinse the bottle three times and let to dry.
• Remove or obliterate the label.
• Place the uncapped bottle next to the garbage receptacle.

6.3.4 RADIOACTIVE WASTE

6.3.4.1. SOLID WASTE (EXCEPT SEALED SOURCES)

• Whenever possible, package alpha emitting radioisotopes separately from other radioisotopes.
• Whenever possible, package long-lived (half life > 10 years) radioisotopes separately from short-lived radioisotopes.
• Accumulate waste in the solid radioactive waste containers provided.
• Update the information on the label as wastes are placed in the container.

6.3.4.2 SEALED AND ENCAPSULATED SOURCES

• Do not package sealed sources with other types of waste materials.
• Contact the safety officer for assistance.

6.3.4.3 LIQUID SCINTILLATION VIALS

• Leave fluids in their vials
• Deposit vials into a designated 45-gallon drum in your building’s waste storage area and enter the required information on an inventory sheet that should be attached to the drum.

7 LABORATORY VENTILATION AND FUME HOODS

7.1 GENERAL VENTILLATION

General ventilation, also called dilution ventilation, involves dilution of inside air with fresh outside air, and is used to:

- Maintain comfortable temperature, humidity and air movement for room occupants
- Dilute indoor air contaminants
- Replace air as it is exhausted to the outside via local ventilation devices such as fume hoods
- Provide a controlled environment for specialized areas such as surgery or computer rooms

General ventilation systems comprise an air supply and an air exhaust. The air may be supplied via a central HVAC (Heating, Ventilation and Air Conditioning) system or especially in older buildings, via openable windows. Laboratory air may be exhausted through either local exhaust devices or air returns connected to the HVAC system.

7.2 LOCAL VENTILATION DEVICES

Local exhaust ventilation systems capture and discharge air contaminates (biological, chemical, radioactive) or heat from points of release. Common local exhaust ventilation device found in laboratories include:

- Chemical fume hoods
- Canopy hoods
- Slotted hoods
- Biological safety cabinets
- Direct connections

7.2.1 CHEMICAL FUME HOODS

Chemicals fume hoods are enclosed units with a sliding slash for opening or closing the hood. They are able to capture and exhaust even heavy vapours, and are preferred for all laboratory procedures that require manual handling of hazardous chemical material.

Refer to Section 7.4 below for the information on the safe use of chemical fume hood. Fume hoods are classified based on the concentration of the hazardous substance that can be used. The annual certification on the fume hood indicates the classification and thereby its use.

7.2.2 CANOPY HOODS

Canopy hood are designed to capture heat from processes or equipment, such as atomic absorption spectrophotometers or autoclaves, a canopy or bonnet is suspended over a process and connected to an exhaust vent. The following limitations make canopy hoods poor substitutes for chemical fume hoods, because they:

- Draw contaminated air through the user's breathing zone
- Do not capture heavy vapours.
- Provide less containment than chemical fume hoods, and are more affected by air turbulence
- Do not provide adequate suction more that a few inches away from the hood opening

7.2.3 SLOTTED HOODS

Slotted hoods, or benches, have one or more narrow horizontal openings, or slots, at the back of the work surface; the slots are connected to exhaust ducting. These special purpose hoods are used for work with chemicals of low to moderate toxicity only, such as developing black and white photography.

7.2.4 BIOLOGICAL SAFETY CABINETS

Biological safety cabinets are for use with biological material; depending on the cabinet class, they provide protection of the environment, user and/or product. They are not recommended for use with hazardous chemicals because most models re-circulate air into the laboratory, and because the HEPA filter that is integral to the protective function can be damage by some chemicals. (check these filters regularly)

7.2.5 DIRECT CONNECTIONS

Direct connections provide direct exhausting of contaminants to the outdoor and are use for venting.

- Flammable liquid storage cabinets
- Other toxic chemical storage cabinets
- Solvent and waste reservoirs.
- Reaction vessels, sample analyzers, ovens, dryers and vacuum pump outlets

7.3 VENTILATION BALANCING AND CONTAINMENT

Generally, more air is exhausted from a laboratory than is supplied to it, resulting in a net negative pressure (vacuum) in the laboratory. Negative pressure draws air into the laboratory from surrounding areas, and serves to prevent airborne hazardous chemicals, radiation or infectious micro organisms from spreading outside the laboratory in the event of an accidental release inside the laboratory. Balancing of laboratory ventilation must take into consideration the amount of air exhausted by local ventilation devices such as fume hoods. Modern laboratories do not have operable windows, as opening of windows tends to pressurize a room, pushing air from the laboratory into adjacent non-laboratory areas.

7.4 SAFE USE OF CHEMICAL FUME HOODS

Fume hoods properly used and maintained will render substantial protection, provided the user is aware of its capabilities and limitations. The performance standard for fume hoods is the delivery of a minimum face velocity of 100 linear feet per minute at half slash height. To ensure your fume hood provides the highest degree of production observe the following guidelines:

1. Only materials being used in an ongoing experiment should be kept in the fume hood. Cluttering the hood will create airflow disturbances.
2. When it is necessary to keep a large apparatus inside a hood, it should be placed upon blocks or legs to allow air flow underneath.
3. Operate the hood with the sash as low as practical. Reducing the open face will increase the face velocity.
4. Work as far into the hood as possible. At least six inches is recommended.
5. Do not lean into the hood. This disturbs the airflow, and also place your head into the contaminated air inside he hood.
6. Do not make quick motions into or out of the hood, or create cross drafts by walking rapidly past the hood. Opening doors or windows can sometimes cause strong air currents, which will disturb the airflow into the hood.
7. Heating devices should be placed at the rear of the hood.
8. Do not use a hood for any function it was not specifically designed to do, such as perchloric acid, some radioisotopes, etc.
9. Keep hood door closed when not attended.
10. Remember that sinks inside fume hoods are not designed for disposal of chemical wastes.

8 COMPRESSED GASES AND CRYOGENICS

8.1 HAZARDS OF COMPRESSED GASES

Compressed gases are hazardous due to the high pressure inside cylinders. Knocking over an unsecured, uncapped cylinder of compressed gas can break the cylinder valve; the resting rapid escape of high-pressure gas can turn a cylinder into an uncontrolled rocket or pinwheel, causing serious injury and damage. Poorly controlled release of compressed gas in the laboratory can burst reaction vessels, cause leaks in equipment and hoses or result in runaway chemical reactions. Compressed gases may also have flammable, oxidizing, dangerously reactive, corrosive or toxic properties. Inert gases such as nitrogen, argon, helium and neon can displace air, reducing oxygen level in poorly ventilated areas and causing asphyxiation.

8.2 SAFE HANDLING, STORAGE AND TRANSPORT OF COMPRESSED GAS CYLINDERS

• All gases cylinders, full or empty, should be securely supported using suitable racks, straps, chains or stands.
• When cylinders are not in use or are being transported, remove the regulator and attach the protective cap.
• An appropriate cylinder cart should be used for transporting cylinders. Chains or strap the cylinder to the cart.
• Verify that the regulator is appropriate for the gas being used and the pressure being delivered. Do not rely upon the pressure gauge to indicate the maximum pressure ratings; check the regulator's specifications.
• Do not use adaptors or Teflon tape to attach regulators to gas cylinders.
• Never bleed a cylinder completely empty; leave a residual pressure.
• Do not lubricate the high-pressure side of an oxygen regulator.
• Do not expose cylinders to temperature extremes.
• Store incompatible classes of separately.

8.3 CRYOGENIC HARZARDS

Cryogenics are low temperate material such as dry ice (solidCO_2) and liquefied air or gases like nitrogen, oxygen, helium, argon and neon. The following hazards are associated with the use of cryogenics:
• Asphyxiation due to displacement of oxygen (does not apply to liquid air and oxygen)
• Embrittlement of materials from extreme cold.
• Frostbite
• Explosion due to pressure build up
• Condensation of oxygen and fuel (e.g. hydrogen and hydrocarbons) resulting in explosive mixtures.

8.4 CRYOGENIC HANDLING PRECAUTION

The following are precautions for handling cryogenics:

• Control ice build up

• Use only low-pressure containers equipped with pressure relief devices.
• Protect skin and eyes from contact; wear eye protection and insulated gloves.
• Use and store in well-ventilated areas.
• Keep away from sparks or flames
• Use materials resistant to embrittlement (e.g. latex rubber tubing).
• Watches, rings, bracelets or other jewelry that could trap fluids against flesh should not be worn when handling cryogenic liquids
• To prevent thermal expansion of contents and rupture of the vessel, do not fill containers to more than 80% of capacity.

9 PHYSICAL HAZARDS AND ERGONOMICS

9.1 ELECTRICAL SAFETY

• Purchase and use only approved electrical equipment.
• All electrical outlets should carry a grounding connection requiring a three-pronged plug.
• Never remove the ground pin of a three-pronged plug.
• Remove cords by grasping the plug, not the cord.
• All electrical equipment (except glass, cloth heaters and certain models of oscillographs requiring a floating ground) should be wired with a grounding plug.
• All wiring should be done by, or under the approval of a licensed electrician.
• Electrical equipment that has been wetted should be disconnected at the main switch or breaker before being handled. Familiarize yourself with the location of such devices.
• Know how to cut off the electrical supply to the laboratory in the event of an emergency.
• Maintain free access to panels; breaker panels should be clearly labeled as to which equipment they control.
• Ensure that all wires are dry before plugging in circuits.
• Electrical equipment with frayed wires should be repaired before being put into operation.
• Tag and disconnected defective equipment.
• Be sure that all electrical potential has discharged before commencing repair work on any equipment containing high voltage power supplies or capacitors.
• Minimize the use of extension cords and avoid placing them across of pedestrian traffic.
• Use only CO2 or dry chemical extinguishers for electrical fires.
• Use ground fault circuit interrupters for all electrical equipment as much as possible particularly in high risk areas.

9.2 HIGH PRESSURE AND VACUUM WORK

Pressure difference between equipment and the atmosphere result in many lab accidents. Glass vessels under vacuum or pressure can implode or explode resulting in cuts from projectiles and splashes to the skin and eyes. Glass can rupture even under small pressure differences. Rapid temperature changes, such as those that occur when removing

containers from liquid cryogenics, can lead to pressure differences, as can carrying out chemical reactions inside sealed containers.

The hazards associated with pressure work can be reduced by:

• Checking for flaws such as cracks, scratches and etching marks before using vacuum apparatus
• Using vessels specifically designed for vacuum work. Thin-walled or round-bottomed flasks larger than 1 L should not be used.
• Assembling vacuum apparatus so as to avoid strain. Heavy apparatus should be supported from below as well as by the neck
• Taping glass vacuum apparatus to minimize projectiles due to implosion
• Using adequate shielding when conducting pressure and vacuum operations
• Allowing pressure to run to the atmospheric before opening vacuum desiccators or after removal of sample container from cryogenics
• Wearing eye or face protection when handling vacuum or pressure apparatus

9.3 GLASSWARE SAFETY

• Use a dustpan and brush, not your hands, to pick up broken glass.
• Discard broken glass in a rigid container separate from garbage and label it appropriately.
• Protect glass that is subject to high pressure or vacuum. Wrapping glass vessels with cloth tape will minimize the possibility of projectiles.
• Glass is weakened by everyday stresses such as heating and bumping. Handle used glassware with extra care.
• Discard or repair all damage glassware, as chipped, cracked or star cracked vessels cannot handle the normal stresses.

When handling glass rods or tubes:

• Fire polish the ends,
• Lubricate with water or glycerine when inserting through stopper
• Ensure stopper holes are properly sized, and are not to small,
• Insert carefully, with a slight twisting motion, keeping hands close together, and
• Use gloves or cloth towel to protect your hands

10 EQUIPMENT SAFETY

Whenever lab equipment is purchased, preference should be given to equipment that

• Limits contact between the operator and hazardous material, and mechanical and electrical energy
• Is corrosion-resistant, easy to decontaminate and impermeable to liquids
• Has no sharp edges or burrs

Every effort should be made to prevent equipment from becoming contaminated. To reduce the likelihood of equipment malfunction that could result in leakage, spill or unnecessary generation of aerosolized pathogens:

• Review the manufacturer's documentation. Keep for future reference. Manuals must be easily accessible to all users of the equipment.
• Use and service equipment according to the manufacturer's instructions.
• Ensure that anyone who uses a specific instrument or piece of equipment is properly trained in setup, use and cleaning of items.
• Decontaminate equipment before it is sent out for repairs or discarded.

The following sections outline some of the precautions and procedures to observe with some commonly used laboratory equipment.

10.1 CENTRIFUGES

Improperly used or maintained centrifuges can present significant hazards to users. Failed mechanical parts can result in release of flying objects, hazardous chemicals and biohazardous aerosols. The high-speed spins generated by centrifuges can create large amounts of aerosol if a spill, leak or tube breakage occurs. To avoid contaminating your centrifuge:

• Check glass and plastic centrifuge tubes for stress lines, hairline cracks and chipped rims before use. Use unbreakable tubes whenever possible.
• Avoid filing tubes to the rim.
• Use caps or stoppers on centrifuge tubes. Avoid using lightweight materials such as aluminum foil as caps.
• Use sealed centrifuge buckets (safety cups) or rotors that can be loaded and unloaded in a biological safety cabinet. Decontaminate the outside of the cups or buckets before and after centrifugation. Inspect o-rings regularly and replace if cracked or dry.
• Ensure that the centrifuge is properly balanced.
• Do not: - open lid during or immediately after operation, attempt to stop a spinning rotor by hand or with an object, or interfere with the interlock safety device.
• Decent supernatants carefully and avoid vigorous shaking when re-suspending.

When using high-speed or ultra centrifuges, additional practices should include:

• Connecting the vacuum pump exhaust to a trap.
• Record each run in a logbook: keep a record of speed and run for each rotor.
• Install a HEPA filter between the centrifuge and the vacuum pump when working with biohazardous material.
• Never exceed the specified speed limitation of the rotor.

10.2 ELECTROPHORESIS EQUIPMENT

• Ensure that electrophoresis equipment is properly grounded and has electrical interlocks. Do not bypass safety interlock.
• Inspect electrophoresis equipment regularly for damage and potential tank leaks.
• Located equipment away from high traffic areas, and away from wet areas such as sinks or washing apparatus.
• Display warning signs.

10.3 HEATING BATHS, WATER BATHS

Heating baths keep immersed materials immersed at a constant temperature. They may be filled with a variety of materials, depending on the bath temperature required; they may contain water, mineral, oil, glycerin, paraffin or silicone oils, with bath temperatures ranging up to 300oC. The following precautions are appropriate for heating baths:

• Set up on a stable surface, away from flammable and combustible materials including wood and paper
• Relocate only after the liquid inside has cooled
• Ensure baths are equipped with redundant heat control or automatic cutoffs that will turn off the power if the temperature exceeds a preset limit.
• Use the thermostat set well below the flash point of the heating liquid in the use
• Equip with a thermometer to allow a visual check of the bath temperature
The most common heating bath used in laboratories is the water bath. When using a water bath:

Clean regularly: - A disinfectant, such as a phenolic detergent, can be added to the water.

Avoid using sodium azide to prevent growth of microorganism; sodium azide forms explosive compound with some metals.

Raise the temperature to 90oC or higher for 30 minutes once a week for decontamination purposes.

Unplug the unit before filing or emptying and have the continuity-to-ground checked on a regular basis

10.4 SHAKERS, BINDERS, SONICATORS

When used with infection agents, mixing equipment such as shakers, blenders, sonicators, grinder and homogenizers can release significant amounts of hazardous aerosols, and should be operated inside a biological safety cabinet whenever possible. Equipment such as blenders and stirrers can also produce large amounts of flammable vapours. The hazards associate with this type of equipment can be minimized by:

• Selecting and purchasing equipment with safety features that minimize leaking
• Selecting and purchasing mixing apparatus with non-sparking motors.

• Checking integrity of gaskets, caps and bottles before using. Discard damaged items.
• Allowing aerosols to settle for at least one minute before opening containers
• Covering tops of blenders with a disinfectant-soaked towel during operation, when using biohazardous material
• When using a sonicator, immersing the tip deeply enough into the solution to avoid creation of aerosols
• Decontaminant exposed surface after use

10.5 OVEN AND HOT PLATES

Laboratory ovens are useful for baking or curing material, off-gassing, dehydrating samples and drying glassware.

• Select and purchase an oven whose design prevents contact between flammable vapours and heating elements or spark producing components
• Discontinue use of any oven whose backup thermostat, pilot light or temperature controller has failed
• Avoid heating toxic materials in an oven unless it is vented outdoors (via a canopy hood, for example)
• Never use laboratory ovens for preparation of food for human consumption
• Glassware that has been rinsed with an organic solvent should be rinsed with distilled water before it is placed in a drying oven

10.6 ANALYTICAL EQUIPMENT

The following instruction for safe use of analytical equipment are general guidelines; consult the user's manual for more detailed information on the specific hazards:

• Ensure that authorized service personnel carry out installation, modification and repairs of analytical equipment.
• Read and understand the manufacturer's instructions before using this equipment.
• Make sure that preventive maintenance procedures are performed as required.
• Do not attempt to defeat safety interlocks.
• Wear safety glasses and lab coats (and other appropriate personal protective equipment as specified) for all procedures.

10.6.1 SCINTILLATION COUNTERS

• Use sample vials that meet the manufacturer's specifications
• Keep counters clean and free of foreign material
• To avoid contaminating the counter and its accessories with radioactivity change gloves before loading racks in the counter or using the computer keyboard. Verify on a regular basis (by wipe testing) that the equipment has not become contaminated.

10.6.2 ATOMIC ABSORPTION (AA) SPECTROMETERS

Sample preparation for atomic absorption procedures often require handling of flammable, toxic and corrosive products. Familiarize yourself with the physical, chemical and toxicological properties of these materials and follow the recommended safety precautions. Consult MSDS. Atomic absorption equipment must be adequately vented, as toxic gases, fumes and vapours are emitted during operation. Other recommendations to follow when carrying out atomic absorption analysis are:

• Wear safety glasses for mechanical protection.
• Check the integrity of the burner, drain and gas system before use.
• Inspect the drain system regularly; empty the drain bottle frequently when running organic solvents.
• Allow the burner head to cool to room temperature before handling.
• Never leave the flame unattended. A fire extinguisher should be located nearby.
• Avoid viewing the flame or furnace during atomization unless wearing protective eyewear.
• Hollow cathode lamps are under negative pressure and should be handled with care and disposed of properly to minimize implosion risks.

10.6.3 MASS SPECTROMETERS (MS)

Mass spectrometry requires the handling of compressed gases and flammable and toxic chemicals. Consult MSDS for products before using them. Specific precautions for working with the mass spectrometer include:

• Avoid contact with heated parts while the mass spectrometer is in operation.
• Verify gas, pump, exhaust and drain system tubing and connections before each use.
• Ensure that pumps are vented outside the laboratory, as pump exhaust may contain traces of the samples being analyzed, solvents and reagent gas.
• Used pump oil may also contain traces of analytes and should be handled as hazardous waste.

10.6.4 GAS CHROMATOGRAPHS (GC)

Gas chromatography requires handling compressed gases (nitrogen, hydrogen, argon, helium) and flammable and toxic chemicals. Consult product MSDSs for products before using them. Specific precautions for working with gas chromatographs include:

• Perform periodic visual inspections and pressure leak tests of the sampling system plumbing, fittings and valves.
• Follow the manufacturer’s instructions when installing columns. Glass fused capillary columns are fragile: handle them with care and wear safety glasses to protect eyes from flying particles while handling, cutting or installing capillary columns.
• Turn off and allow heated areas such as the oven, inlet and detector, as well as connected hardware, to cool down before touching them.
• To avoid electrical shock, turn off the instrument and disconnect the power cord at its receptacle whenever the access panel is removed.

• Turn off the hydrogen gas supply at its source when changing columns or servicing the instrument.
• When using hydrogen as fuel (flame ionization [FID] and nitrogen-phosphorus detectors [NPD]), ensure that a column or cap is connected to the inlet fitting whenever hydrogen is supplied to the instrument to avoid buildup of explosive hydrogen gas in the oven.
• Measure hydrogen gas and air separately when determining gas flow rates.
• Perform a radioactive leak test (wipe test) on electron capture detectors (EDCs) at least every 6 month for sources of 50MBq (1.35 mCi) or greater and document.
• Ensure that the exhaust from (EDCs) is vented to the outside.
• When performing split sampling, connect the split vent to an exhaust ventilation system or appropriate chemical trap if toxic materials are analyzed or hydrogen is used as the carrier gas.
• Use only helium or nitrogen gases, never hydrogen, to condition a chemical trap.

10.6.5 NUCLEAR MAGNETIC RESONANCE (NMR) EQUIPMENT

The superconducting magnet of NMR equipment produces strong magnetic and electromagnetic fields that can interfere with the function of cardiac pacemakers. Users of pacemakers and other implanted ferromagnetic medical devices are advised to consult with their physician, the pacemaker's manual and pacemaker manufacturer before entering facilities which house NMR equipment. Precautions for work with NMR include the following:

• Post clearly visible warning signs in area with strong magnetic fields.
• Measure stray fields with a gaussmeter, and restrict public access to areas of 5-gauss or higher.
• The strong magnetic field can suddenly pull nearby unrestrained magnetic objects into the magnet with considerable force. Keep all tools, equipment and personal items containing ferromagnetic material (e.g., steel, iron) at least 2 meters away from the magnet.
• Though not a safety issue, advise users that the magnetic field can erase magnetic medias such as tapes and floppy disk, disable credit and automated teller machine (ATM) cards, and damage analog watches.
• Avoid skin contract with cryogenic (liquid) helium and nitrogen; wear a protective face mask and loose-fitting thermal gloves during dewar servicing and when handling frozen samples. Refer to section 11. "Compressed Gases and Cryogenics".
• Ensure that ventilation is sufficient to remove the helium or nitrogen gas exhausted by the instrument.
• Avoid positioning your head over the helium and nitrogen exit tubes.
• NMR tubes are thin-walled; handle them carefully and reserve them for NMR use only.

10.6.6 HIGH-PRESSURE LIQUID CHROMATOGRAPHY (HPLC)

HPLC producers may require handling of compressed gas (helium) and flammable and toxic chemicals. Familiarize yourself with the hazardous properties of these products, as well as recommended precautionary measures, by referring to MSDSs.

• Inspect the drain system regularly; empty the waste container frequently when using organic solvents.
• Ensure the waste collection vessels are vented.
• Never use solvents with auto ignition temperatures below 11oC.
• Be sure to use a heavy walled flask if you plan to use vacuum to degas the solvent.
• Never clean a flowcell by forcing solvents through a syringe: syringes under pressure can leak or rupture, resulting in sudden release of syringe contents.
• High voltage and internal moving parts are present in the pump. Switch off the electrical power and disconnected the line cord when performing routine maintenance of the pump.
• Shut down and allow the system to return to atmospheric pressure before carrying out maintenance procedures.

10.6.7 LIQIUD CHROMATOGRAPHY (LC/MS)

LC/MS requires the handling of compressed nitrogen and flammable and toxic chemicals. Consult product MSDSs before using them. Specific precautions for working with LC/MS equipment include:

• Verify gas, pump exhaust and drain system tube and connections before each use.
• Test the pressure switch for the exhaust line before each use.
• Ensure that pumps are vented outside the laboratory.

11 PERSONAL PROTECTIVE EQUIPMENT

11.1 EYE PROTECTION

Eye protection is required in all laboratories where infectious, corrosive or toxic materials are used or stored, and anywhere near high pressure or high vacuum, or when carrying out work that can generate dust, spray or other projectiles. Wear protection appropriate for working being performed:

• Light work: glasses should be unbreakable lenses (plastic or heat-tempered glass).
• Light-to-moderate work: glasses with side shields.
• Work with significant risk of splash of chemicals, or projectiles: goggles.
• Work with significant risk of splash on face, or possible explosion: full face shield, plus goggles.
• If safety glasses with correction lenses are needed, first consult with your optometrist or ophthalmologist.

11.2 HAND PROTECTION

In the laboratory, gloves are used for protection from radiation, chemical products, biohardous material and physical hazards such as abrasion, puncture and exposure to temperature extremes.

11.2.1 LATEX GLOVES AND SKIN REACTIONS

Natural latex is derived from the sap of the rubber tree and contains rubber polymers, carbohydrates, lipids, phospholipids and proteins. During the manufacturing process additional chemical agents are added to impart elasticity, flexibility and durability to the latex. Because of these properties, and because of their high tactile strength and low cost, latex gloves are used for many laboratory procedures. Unfortunately, for some people, wearing latex gloves can cause skin reactions; these can be either irritant or allergic in nature, and can be caused by:

- Chronic irritation from sweating of hands inside gloves or from gloves rubbing against the skin
- Sensitization to the chemical additive used in manufacturing process
- Reaction to naturally-occurring latex proteins

Frequent hand washing, as well as residues from scrubs, soaps, cleaning agents and disinfectants may further irritate the skin.

Using one of the following alternatives may reduce the risk of skin problems associated with the use of latex rubber gloves:

- Non-latex gloves
- “Hypo-allergenic”, non-powdered or low-protein latex gloves
- Polyethlene, PVC or cloth liners under latex gloves
- Non-latex gloves under latex gloves

Occurrences of skin problems (e.g., rash itching, peeling, red, blistering skin or dry flaking skin with cracks and sores) that seem to be associated with wearing the latex gloves should be reported to a doctor when systems first appear.

11.2.2 GLOVE SELECTION GUILDLINES

Base selection of gloves material on:

- Identification of the work procedures requiring hand protection
- Flexibility and touch sensitivity required; a need for high tactile sensitivity, for example, would restrict glove thickness, and some protocols any require the use of gloves with non-slip or textured surfaces
- Whether disposal or reusable gloves are more appropriate

Recommended glove materials for a variety of laboratory hazards.

Trademark names were included because the reader is likely to encounter them in the literature. Consult laboratory or safety equipment suppliers, or the manufacturer, for more information on brand name gloves. Gloves not listed here may also be suitable; refer to MSDS, glove manufacturer or permeation chart. The section on electricity is included for information purpose only, as all electrical work must be done by licensed electricians.

Guide to the Selection of Skin Protection
Hazard Degree of Hazard Recommended Material
Abrasion Severe Reinforced heavy rubberstaple-reinforced leather
Less severe Rubber, plastic, leather, polyester, nylon, cotton
Sharp edges Severe Metal meshstaple-reinforced heavy leather Kevlararmid-steel
Less severe Leather terry cloth (aramid fibre)
Mild with delicate work Lightweight, leather, polyester, nylon, cotton
Chemicals and liquids Varies depending on the concentration contact time, etc. Consult MSDS manufacturer or permeation chart Choice depends on chemical. Examples: nature, nitrile or butyl rubber, neoprene, PTFE (polytetrafluoroethylene), polyvinyl choride, polyvinyl alcohol, teflonTM, VitronTM, SaranexTM,4HTM, ChemrelTM, BarricadeTM, ResponderTM
Cold Leatherinsulated plastic or rubberwoolcotton
Heat Over 350 °C Asdestos Zetex TM
Up to 350 °C Neoprene-coated asbestosheat-resistance leather with linings Nomex Kevelar
Up t0 2000 °C Heat-resistant leatherterry cloth (aramid fibre) Nomex Kelvar TM
Up to 100 °C Chrome-tanned leatherterry cloth
Rubber-insulated gloves tested to appropriate voltage (CSA Standard Z259.4-M1979) with leather outer glove
General duty Cottonterry clothleather
Product contamination Thin-film plastic light weight leathercottonpolyesternylon
Radiation Low to moderate radiotoxicity Any disposable rubber or plastic gloves

11.2.3 CHEMICAL GLOVE SECECTION

No single glove material is resistant to all chemicals, nor will most gloves remain resistant to a specific chemical for longer that a few hours. Determine which gloves will provide an acceptable degree of resistance by consulting the MSDS for the product, contacting glove manufacturers or by referring to a compatibility chart or table for permeation data. These resources may use the following terms:

• “permeation rate” refers to how quickly the chemical seeps through the intact material: the higher the permeation rate the faster the chemical will permeate the material;
• “breakthrough time” refers to how long it take the chemical to seep through the other side of the material, and

• “degradation” is a measure of the physical deterioration (for example, glove material may actually dissolve or become harder, softer or weaker) following contact with the chemical

11.2.4 SECTION, USE AND CARE OF PROTECTIVE GLOVES

Guidelines of glove use include the following:

• Choose a glove that provides adequate protection from the specific hazard(s)
• Be aware that some glove materials may cause adverse skin reaction in some individuals and investigate alternatives
• Inspect gloves for leakage before using; test rubber and synthetic gloves by inflating them
• Make sure that the gloves fits properly
• Ensure that the gloves are long enough to cover the skin between the top of the gloves and the sleeve of the lab coat
• Discard worn or torn gloves
• Discard disposable gloves that are, or may have become, contaminated
• Avoid contaminating “clean” equipment; remove gloves and wash hands before carrying out tasks such as using the telephone
• Always wash your hands after removing gloves, even if they appear not to be contaminated
• Do not reuse disposable gloves
• Follow the manufacturer’s instructions for cleaning and maintenance of reusable gloves
• Before using gloves, learn how to remove them without touching the contaminated outer surface with your hands

11.3 PROTECTIVE CLOTHING

While protective equipment, such as eyewear, gloves and respirators is needed under specific conditions or for specific task, laboratory workers must wear lab coat at all times in the laboratory. Instructions for selection and use of protective laboratory clothing are as follows:

• Select Knee-length lab coats with button or snap closures
• Wear a solid-front lab coat or gown with back closures and knitted cuffs when working with high toxic or infectious agents
• Wear protective aprons for special procedures such as transporting large volumes of corrosive materials
• Remove protective clothes when leaving the laboratory
• Remove protective clothes in the event of visible or suspected contamination

11.4 RESPIRATORS

Respirators should be used only in emergency situations (e.g. hazardous spill or leaks) or when other measures, such as ventilation, cannot adequately control exposures. There are

two classes of respirators, air purifying and supplied-air respirators. The latter supply clean air from a compressed air tank or through an air line outside the work area, and are used in oxygen-deficient atmospheres or when gases or vapours with poor warning properties are presented in dangerous concentrations. Air-purifying respirators are suitable for many laboratory applications and remove particulates (dusts, mists, mental fumes etc.) or gases and vapours form the surrounding air.

11.4.1 SELECTION, USE AND CARE OR RESPIRATORS

Follow proper procedures for selecting and using respiratory protective equipment. Correct use of a respirator is vital as choosing the right respirator. An effective program for respiratory protection should include the following:

• Written standard operating procedure and training. Consult Safety officer
• Selecting a respirator that is suitable for the application. Consult the MSDS or the Safety Officer before purchasing and using a respirator
• Assigning respirators to individuals for their exclusive use, whenever possible
• Fit-testing: evaluation of facial fit for all users of respirators; beards, long sideburns, glasses or the wrong size of respirator may prevent an effective seal between the wearer's face and the respirator
• Protocols for using, cleaning and sanitary storage of respirators
• Regular inspection of the respirator, and replacement of defective parts
• Medical surveillance, before an individual is assigned to work in an area where respirators are required, to verify the person's ability to function under increase breathing resistance.

12 EMERGENCY PROCEDURES

12.1 FIRST AID

Know how to handle emergency situation before they occur:

• Become familiar with the properties of the hazardous products used in your area.
• Familiarize yourself with the contents of the first aid kit and learn how to use them, keep instructions readily available and easy to understand.
• Locate and know how to test and operate emergency equipment, such as shower and eyewash, in your area.
• Obtain First Aid Training: Contact the Safety Officer for the date of the next First Aid and CPR course.

The emergency first aid procedure described below should be followed by a consultation with a doctor for medical treatment.

12.1.1 BURNS

In the laboratory, thermal burns may be caused by intense heat, flames, molten metal, steam etc. corrosive liquids or solids such as bases and acids can cause chemical burns; first aid treatment for chemical burns. In electrical burns, electrical current passing through the body generates heat.

12.1.1.1 BURNS TO THE SKIN

First aid treatment of skin burns encompasses the following:

• If the burns are electrical in the origin, ascertain that the victim is not in contact with the power supply before touching him/her. If the victim remains in contact with a power source, unplug the device or shut of the main power switch at the electrical distribution panel.
• Seek immediate medical treatment for all electrical burns, even if they don't appear to be serious.
• Remove jewelry, including watches, from the burned area.
• Expose the burnt area, but avoid removing clothes that are stuck to skin
• If possible flush surfaces with water for at least 20 minutes
• Avoid applying lotions, ointments or disinfectants to burn. First and second-degree burns can be washed with soap and water after the cool down period.
• Cover first and second degree burns with a moist bandage; apply dry compresses to third degree burns and to entry and exit wounds of electrical burns.
• Do not burst blisters, as they form a natural barrier against infection.

12.1.1.2 BURNS TO THE EYES

Burns to the eyes may be caused by chemical substances, heat (hot liquids, steam, open flames, molten metal, etc.), or radiation from welding procedures, laboratory lamps and lasers. Burns caused by ultraviolet, visible or near-infrared radiation may not produce symptoms until 6-8 hours after exposure. First aid procedures for chemical burns to the eyes. General first aid procedure for thermal and radiation burns to the eyes are as follows:

• Prevent the victim from rubbing or touching the eyes.
• For heat burns, flush the eyes with cool water until the pain subsides.
• Cover the eye with dry sterile gauze pad; apply a wet compress to eyes if it is too painful to close them.
• Send the victim for medical care. If the burn is the result of exposure to a laser beam, advise emergency medical personnel of the characteristics of the laser and the distance of the victim and the laser.

12.1.2 CUTS

First aid treatment for minor scrapes, scratches, cuts, lacerations or puncture wounds include the following:

• Wash the wound and surrounding area with mild soap and running water
• Remove any dirt around the wound
• Cover with an adhesive dressing or gauze square taped on all side with adhesive tape
• Wound caused by dirty, soiled or grimy objects should be examined by a doctor, who will determine whether a tetanus injection is needed
• If the wound was caused by an object that has contacted human blood or body fluids, the victim must be seen by a doctor immediately, as immunization of post-exposure prophylaxis may be required
• If wound is bleeding profusely, the first aider should attempt to stop the bleeding as quickly as possible:
• Elevate the injured area above the level of the heart, if possible, in order to reduce the blood pressure to the area of the wound.
• Apply direct pressure to the wound unless an object is protruding from it (in the situation, apply pressure around the injury). Direct pressure can be applied with the fingers of the hand, the palm of the hand or with a pressure dressing.
• If bleeding cannot be controlled with direct pressure, apply pressure to the arteries supplying the injured area. This involves compressing the artery between the wound and the heart, against a bone.
• Don not remove a dressing that has become soak with blood, as this may interrupt the clotting process; apply an additional dressing on top of the first.
• Avoid over-tightening of the dressing; i.e., don not cut off the blood circulation to the limbs.
• As a tourniquet completely stops the flow of blood to beyond the point of application, it should be applied only as the last resort, as in the case of a severed limb.

12.1.3 NEEDLESTICK INJURIES

Treat bleeding needle-related injuries as describe above. Consult a doctor immediately, as post-exposure prophylaxis or immunization may be required.

12.1.4 CHEMICAL SPLASHES TO THE SKIN OR EYES

For splashes to the skin:

• If the splash affect large area of skin, go to the nearest shower and rinse thoroughly for at least 20 minutes; remove contaminated clothing while in the shower
• For splashes involving a small skin area, proceed to the nearest drench hose, remove contaminated clothing and jewelry and rinse for 15 minutes.

For splashes to the eyes:

• Go to the nearest eyewash and rinse for at least 20 minutes.
• Contact lens should not be worn in the laboratories. If however someone was wearing contact lenses, remove them quickly as possible, while continuing to flush.

• Hold your eyelids open with your fingers.
• Roll your eyeballs, so that water can flow over the entire surface of the eye.
• Lift your eyelids frequently to ensure complete flushing.
• Cover the injured eye with dry sterile gauze pads while waiting for medical attention.

12.1.5 POISONING

Toxic substances can enter and poison the body by inhalation, absorption through the skin, ingestion or injection. When assisting a victim of poisoning:

• Call for ambulance for serious poisoning through the Health Center or The Security Department
• Ensure that the area is safe to enter before attempting to aid the victim
• Move the victim away from the contaminated area and provide first aid as required
• Do not induce vomiting unless advised to do so by a reliable authority.
• Provide emergency medical personnel with the MSDS for the poisonous product. If the victim was overcome by an unknown poison and has vomited, provide the ambulance technicians with a sample of the vomit.
• Always ensure that the victim receives medical attention, even if the exposure seems minor.

12.2 FIRES

The immediate response depends on the size of the fire. Laboratory personnel should attempt to extinguish a fire only if it is clearly safe to do so.

12.2.1 SUSPECTED FIRES

All members of the University community should familiarize themselves with the locations of fire extinguishers, fire hoses, pull stations and evacuation routes in the areas that they occupy. Anyone discovering smoke, strong smell of burning or smell of an unusual nature, should immediately:

• Raise an Alarm
• Inform Security 2120 or have someone do it
• Call extension 3134 and 3138 or have someone do it
• Shut off gas supply and electricity or have someone do it.
• Attempt to out the fire if it is small and if they are competent.

12.2.2 KNOWN FIRES

• Shout “FIRE!” repeatedly to give the alert.
• Pull the alarm if equipped
• Evacuate the premises in a swift, orderly fashion using the stairways and /or fire escapes, but NOT the elevators, and following the instructions of Evacuation Monitors.

• Inform the Warden of the location, magnitude and nature (e.g. Electrical) of the fire, the open evacuation routes, individuals requiring assistance, and other pertinent details.
• Once outside the building, move away from the doors to enable others to exit and move to the emergency assembly point.

12.2.3 CLOTHING FIRES

If your clothing should catch fire, it is important not to run, as this would provided additional air to support the flames. Remember the “Stop, Drop and Roll” rule:

• Stop were you are
• Drop to the floor, and
• Roll to smother the flames

As soon as the flames are extinguished, go to the nearest emergency shower to cool burned are with copious amounts of water.
If someone else is on fire:
• Immediately immobilize the victim and force him/her to roll on the ground to extinguish the flames.
• Assist in smothering the flame, using whatever is immediately available, such as a fire proof blanket or clothing.
• Give appropriate first aid

12.3 HAZARDOUS CHEMICAL SPILLS

In the event of a spill a hazardous (volatile, toxic, corrosive, reactive or flammable) chemical, the following procedures should be following procedures should be followed:

• If there is a fire, raise an alarm. If you are unable to control or extinguish a fire, follow the fire evacuation procedure.
• If the spill is a laboratory, shop or chemical storeroom:
- Evacuate all personnel from the room
- Be sure the hood/local exhaust is on
- If flammable liquids are spilled, disconnect the electricity sources of ignition if possible
- Call the campus emergency telephone numbers listed to request additional assistance if you cannot manage the clean up yourself.
• If the spill is in a corridor or other public passageway:
- Evacuate all people from the area and close off the area to keep others out.
- Call the emergency telephone listed to have the air system in the area shut down (to prevent contamination of other areas) and to request additional assistance.

12.4 NATURAL GAS LEAKS

Have the natural gas valves have been turned off.

• Check that all gas valves have been turned off.

• Call Security and Report
• Call Reports Desk Ext 3134 and report.

Flammability Classification (NFPA) and Permissible Container Sizes (OSHA)

Flammable Liquids Flash Point Range
Boiling Point Range
Class Examples Degree Celcius Glass Metal or Plastic Safety Can
1A Acetaldehyde

Ethyl Ether

Pentane FP<22.8

BP<37.8 .5 4 7.5
1B Acetone

Ethanol

Toluene FP<22.8

BP>37.8 1 20 20
1C Isobutanol

Styrene FP 22.8

FP<37.8 1 20 20
Combustible Liquids
Class Example
II Kerosene

Acetic Anhydride FP37.8

FP<60 4 20 20
IIA Aniline

Octanol FP 60

FP<93.4 4 20 20
IIIB Ethylene

Glycol

Benzyl Alcohol FP 93.4 4 20 20

Though we've tried to provide an extensive laboratory safety manual, it is by no means exhaustive. The information provided is the simply minimum requirement for safe work practices and at times is quite general. All attempts must be made to exceed these. No amount of rules or procedures would make a difference unless there is a change in the way we do things and the things that we allow. Behaviour modification and change in attitudes won't happen overnight but will come about if we have the combined effort of management and employees. Departments/Units are expected to develop their own Lab Specific Safety Manual that deals with hazards pertinent to their area.