Health, Safety and Environmental Manual

Chemical Engineering

Al Imam Mohammad Ibn Saud

Islamic University

Contents

Important Phone Numbers

Central Service	2580000
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1.0 Introduction

Al Imam Mohammad Ibn Saud Islamic University is intended to assist members of the campus community in *preventing* injury and illness and *promoting* their well-being. Various topics are covered with recommended health, safety and environment practices outlined in accordance with health, safety and environment legislation.

The university adheres the constitution of Saudi Arabia which, under Article 32 sets forth the requirement for the country to preserve, protect, and improve the environment. The main implementing regulations addressing environmental and occupational health and safety issues in Saudi Arabia are the Labor Law and the General Environmental Law, implemented by the Rules for Implementation. The President of Meteorology and Environment is the primary agency in the Kingdom of Saudi Arabia with responsibility of environmental issues. It is responsible for the environmental survey, pollution assessment and control. This agency also has established environmental standards and regulations. The occupational health and safety are governed by the Ministry of Labor. It ensures that the university take all necessary precautions to protect workers from hazards, occupational diseases and work safety.

While the HSE Program strives to be comprehensive it is only a relatively brief summary of information. Further health, safety and environment resources are available to persons in their Departments, Faculties and the Library.

Internal Responsibility System

Faculty, staff, students, visitors and contractors share responsibility for health, safety and environment. This concept of an internal responsibility system is based on the principle that members of the campus community are in the best position to identify health, safety and environment problems and to develop solutions. The internal responsibility system involves everyone, from senior administration to workers and students and is fostered by Labor Law (2005) 17.

2.0 Laboratory Safety Practices

2.1 General Safety Awareness and Practices

- Know all the safety rules and procedures that apply to your work. *IF YOU DO NOT UNDERSTAND - ASK!*
- Determine the potential hazards, appropriate safety precautions and proper waste disposal techniques before beginning any new operation.
- Know the location and proper use of emergency equipment (safety showers, eye baths, fire extinguisher, and first aid kits)
- Be familiar with emergency procedures (exits, alarm stations, and evacuation routes)
- Do not eat, drink, smoke or apply cosmetics in any laboratory.
- Do not pipette or start siphons by mouth.
- Wash hands with soap and water before leaving the work area. This applies even if one has been wearing gloves
- Know what protective equipment is available and use the proper type for each experiment
- Ensure that all chemicals are correctly and clearly labeled.
- Use laboratory equipment only for its designated purpose.
- Combine reagents in appropriate order. (i.e., pour water first and then acid; and avoid adding solids to hot liquids)
- Wipe up spills immediately.
- Keep sinks clean. Practice good housekeeping and clean up at the end lab work.
- Keep aisles free of obstructions (chairs, stools, boxes, etc.). Apparatus set up should be as far back on bench as conveniently possible so it will not tip onto floor.
- Do not set up apparatus so that it is necessary to reach through the assembly to turn water, gas, or electricity on or off. Assemble apparatus so that control valves and switches will remain accessible if a fire should occur.
- Confine loose clothing when in the laboratory
- Avoid exposures to gases, vapors, and aerosols (USE FUME HOODS)
- Do not leave experiments in process unattended. (If you must leave equipment running over night please post contact information near experiment)
- Identify shut off switches and ensure they are easily accessible.
- Children should not be allowed in the laboratory.
- Avoid working alone at night.

- ❖ Keep laboratories locked when unoccupied. (Leave doors unlocked while working in laboratory in case assistance is needed)
- ❖ Do NOT wear protective gloves outside the lab area, to avoid contamination on door handles, water fountains, etc.

If you are not already fully knowledgeable of the following, please learn about the following:

- emergency telephone numbers
- proper use of fire extinguishers
- proper means of disposing of broken glassware
- proper disposal of "sharps"
- proper use of safety showers and eye-wash fountains
- correct storage and handling or dispensing of flammable liquids
- proper procedures for radiation monitoring and control, if applicable
- proper procedures for chemical or biological spill clean-up and disposal
- correct operation of fume hoods or biological safety cabinets, if applicable

In the laboratory areas where you work, find and remember the location of:

- telephones
- exits, especially emergency exit routes should be planned in advance.
- fire extinguishers
- fire alarm stations
- safety showers
- eye-wash stations
- first-aid kit
- designated building door for ambulance arrival

2.2 Rules for Working Alone

You should never work alone in a laboratory if the research involves operations that may be hazardous or potentially hazardous to a significant degree. Some examples are: the use of large quantities of flammable liquids (i.e., more than about 2 L) or smaller amounts of flammable liquids contained in an apparatus at elevated temperature and pressure; toxic gases, liquids, or solids; high-pressure systems; moving equipment and machinery (excluding pumps and compressors with the required shaft guards in place); cold rooms. If you are working inside any confined space, vessel or other chamber from which escape would be difficult or delayed, there be at least one person in attendance outside of the work area at all times.

2.2.2 Undergraduate Research Students

The term *undergraduate research students* means all undergraduate students involved in research pertaining to degree requirements. To perform experimental research work in a laboratory, an undergraduate student must have prior authorization from his instructor. The

granting of such authorization should be contingent upon the prior submission by the undergraduate researcher of an acceptable work plan

2.3 Fire Prevention

Fire may be caused by flammable liquids, electrical hazards, smoking, hot surfaces, sparks, poor housekeeping, and arson. Precautions must be taken to aid in the prevention of fire to reduce the risk of loss of life and property.

Flammable Liquids

1. Store flammable liquids only in approved safety cans or storage cabinets. Label the containers and keep them in areas that are well ventilated, away from any heat sources.
2. Clean up spills immediately.
3. Store oily rags in a covered metal container with a self-closing cover and the containers must be emptied daily.
4. Never smoke or light a match near flammable liquids.

Electrical Fire Hazards

1. Check tools, equipment, extension cords and plugs for worn spots and exposed wires.
2. Keep switch boxes clean and closed.
3. Don't try to use broken power tools or equipment, report them to the supervisor.
4. Repairs on broken power tools should only be performed by competent personnel.
5. Inspect equipment at regular intervals.

Hot Surfaces

1. Keep floor clean to prevent falling sparks and hot metal from causing a fire. Cover wood floors with metal or other non-combustible material.
2. Use fire retardant curtains.
3. Turn off and unplug appliances such as soldering irons and coffee pots when workday is over.

Sparks

1. Use brass or plastic tools when working with flammable liquids.
2. Oil motor bearings frequently.
3. Take precautions with metal to metal or metal to concrete contacts.
4. Ensure containers for flammable liquids are grounded and bonded to prevent static electricity from causing a spark.

2.4 Fire Fighting

If you discover a fire:

- Attempt to extinguish fire only if you can do it safely.
- Immediately warn others: activate the fire alarm and start evacuation of the building.
- See emergency procedures of this manual for further information.

2.5 Personal Protection

2.5.1 Eye and Face

Instructors, supervisors and all other persons in authority shall explain the reasons why safety glasses or other types of eye protection equipment should be worn and it will be their responsibility to ensure that students, faculty, staff and visitors are provided with eye protectors in all areas were required.

All persons assigned to, or entering areas which have any of the following hazards must wear eye protectors:

1. Sparks, open flame and spatters.
2. Molten metals.
3. Research activities involving high energy, the possibility of flying particles, explosion or implosion of vessels.
4. Hazardous chemicals.
5. Shops: wood or metal processing, particularly grinding, welding, chipping, sawing and sanding.
6. Injurious radiant energy, for example, welding, ultra-violet light, lasers and brasing.

If a chemical or other substance enters the eye, flowing fresh water (eye fountain or eye-wash station at sink) should be used immediately to flush out the eye for a minimum of 10 minutes. After flushing, report immediately to the Health Services (2583110). When Health Services is closed, have someone immediately take you to the nearest Hospital Emergency. If you are working alone, call the central operator (2580000) for help.

Contact lenses are not to be worn if water-soluble gases of a corrosive or irritating nature, vapours, dusts or other hazardous substances could be released into the work environment. Contact lenses can trap and hold damaging materials or chemicals against the eyeball, or the lenses may melt onto the eyeball in the presence of some dissolved chemical vapours.

2.5.2 Feet

Classification of Safety Footwear

1. Select a certified footwear. Ensure that it has the proper rating for the hazard and the proper sole for the working conditions
2. Employees requiring foot protection shall be aided by subsidy paid by the university, prior approval must be obtained from your supervisor
3. Use metatarsal protection (top of the foot between the toes and ankle) where there is a potential for injury

2.5.3 Hands

2.5.3.1 Handling Chemicals or Biological Agents

Gloves reduce the exposure of our hands to hazardous materials. No single material will protect against all chemicals, so glove selection must be made for each type of chemical. Latex gloves may provide adequate protection against dilute aqueous solutions; they however provide no protection against exposure to most solvents. Table 5 below is intended as a guideline for selection of the appropriate protective glove. Manufacturers can supply specific information on the choice of glove.

Glove selection should be based on the following criteria:

Degradation

Degradation due to contact with chemicals causes the glove material to soften, swell, shrink, stretch, dissolve, or to become hard and brittle.

Permeation

Permeation is the result of molecular diffusion of a chemical through a glove material. There may be permeation without obvious signs of degradation. Permeation is quantified by breakthrough time and permeation rate.

Breakthrough Time

Breakthrough Time is the time it takes for a particular chemical to pass through a protective material.

Permeation Rate

The speed at which the chemical moves through the protective material once it has broken through.

Exposure

Glove performance is decreased significantly as chemical exposure is increased by the following:

- Chemical concentration

- Direct immersion
- Pervious exposures

Temperature

Permeation test data are obtained at room temperature (20 to 25 degrees Celsius). If chemicals are being used at temperatures higher than this glove performance may be significantly affected.

Glove Thickness

Any chemical will permeate a protective material given enough time. The breakthrough time for a thicker material will be longer than that of a thinner material, providing superior chemical resistance. When choosing a chemically resistant glove manual dexterity must also be taken into account.

Manufacturer

Differences in production of materials results in variations of permeation and degradation between manufactures. Test data for a particular manufacture should be consulted prior to selecting a chemically resistant glove.

Chemical Purity

Permeation testing is conducted using pure chemicals. Mixtures of chemicals will significantly alter the permeation rate and degradation of a material.

Physical Resistance

Chemical penetration through a tear or hole in a glove will cause a much greater chemical exposure potential than caused by molecular permeation.

2.5.4 Hearing (Permitted Exposure to Noise)

No one is permitted to work in an area where the sound level equals or exceeds 115 decibels (dB) unless adequate hearing protection is worn.

2.6 Unattended Experiments

Permission to operate unattended experiments must be obtained in advance from the supervisor. Normally, authorization will be given only if the experiment does not involve the use or production of toxic or bio-hazardous substances, flammable solvents, highly explosive vapours or gases, the use of high pressures or temperatures, or the use of high levels or radioactivity which may be released if the equipment fails.

Experiments which are to be left unattended and which involve temporary connections to building water or steam supplies are to:

(a) Use tubing in good condition, and of the proper pressure rating

(b) Have all water hoses wired or clamped at connecting points

(c) Use water lines equipped with a needle valve or other flow-restrictor located immediately next to the main supply line

If possible, all steam, water and gas lines should be equipped with automatic safety shut-offs (e.g., solenoid valves) which are activated in the event of electrical power failure or other experimental problems such as equipment failure.

2.7 First Aid

Department of Chemical Engineeringis responsible for:

- maintaining first aid stations and reporting their locations to the laboratory user;
- Ensuring first aid stations are readily accessible for the treatment of injured/ill persons.
- designating qualified First Aiders for all their work area first aid stations;
- providing Person(s) in Charge to maintain and inspect first aid stations/kits; and
- Providing additional first aid kits in lab, shop, studio, vehicle and satellite maintenance areas.

2.7.1 Procedure for Blood and Body Fluids

- Preliminary first aid should be administered.
- Use non latex gloves from a first aid kit.
- As soon as possible thereafter, all blood and body fluids should be carefully washed off with hot soapy water.
- To clean surfaces soiled by blood and body fluids, wash with a disinfecting solution, such as bleach, in a dilution of 1 part disinfecting solution to 10 parts water. Gloves should be worn and disposable materials such as paper towels used. Mops should be rinsed in the disinfecting solution.
- Blood and body fluids stained clothing, cloths and other cleaning material should be rinsed out in cold water using non latex gloves and then laundered normally.
- Blood and body fluids stained disposable articles, including gloves should be placed in a plastic bag, securely closed and placed in the regular garbage.

2.7.2 Procedure for First Aid Injury Reporting

All members of the University community must report to their supervisor any injury or illness related to their work or assignments. It is the supervisor's responsibility to ensure that prompt first aid and health care treatment is obtained, if necessary, and that University reports are completed by the end of the next University business day.

- Obtain medical aid if necessary
- Report any injury to your supervisor immediately.

- Complete the Injury/Incident Report with supervisor

2.7.3 Procedure for Transportation for a Workplace Injury

Department and supervisor must provide immediate transportation to Health Services, a hospital, a doctor's office, a walk-in clinic or the worker's home, if necessary.

2.8 Eye/Face Washes and Safety Showers

2.8.1 Location

- Eyewash must be within 11 seconds travel distance and on the same level.
- Path of travel shall be free of obstructions that may inhibit the use of the equipment.
- Location identified by a highly visible sign.
- Location shall be easily accessible and well lit.

2.8.2 Maintenance

- Activated weekly by room occupants.
- Plant Operations to conduct annual inspections.

2.8.3 Use

- All persons who might be exposed to hazardous materials shall be instructed in the use of emergency eye/face wash and shower equipment and procedures for medical assistance.
- Review first aid procedures on Material Safety Data Sheets for hazardous materials.
- Use only eye/face wash units on the eyes. Showers are for head and body and should not be used for eyes due to higher water pressure.

3.0 Chemical and Biological Hazards

3.1 Designated Substances

A *designated substance* is *a biological, chemical or physical agent or combination thereof prescribed as a designated substance to which the exposure of a worker is prohibited, restricted, limited, or controlled*. If it is ascertained that the actual or intended use or production of a designated substance in a workplace (including even small quantities in a research laboratory) is *likely to endanger the health of a worker* (researcher or other occupants of the laboratory), the university will require implementation of engineering controls at the workplace and possibly medical surveillance of the researchers involved.

The following are *designated substances*:

- *Lead* (including elemental lead, and inorganic or organic compounds of lead)
- *Asbestos* (including the following fibrous silicates: actinolite, amosite, anthophyllite, chrysolite, crocidolite or tremolite)
- *Asbestos on construction* (repair or removal of asbestos used in building construction)
- *Vinyl chloride*
- *Mercury* (including elemental mercury, and inorganic or organic compounds or mercury)
- *Isocyanates* (toluene diisocyanate; methylene bisphenyl isocyanate; hexamethylene;

1,6-diisocyanate; isophoronediisocyanate)

- *Silica* (crystalline silica in respirable form)
- *Benzene*
- *Acrylonitrile*
- *Coke oven emissions*
- *Arsenic* (including elemental arsenic and inorganic compounds of arsenic, excepting arsine, and including organic compounds of arsenic only where both inorganic and organic compounds of arsenic are present)

*****Supervisors and research workers in laboratories where a designated substance is stored, handled or used shall take the necessary precautions (hygiene practices and facilities; work

methods; engineering controls) to ensure that the *time-weighted average exposure* of a worker to a designated substance does not exceed the limits prescribed by the regulation pertaining to that substance.

******The following procedures are to be followed when handling a designated substance or any chemical which has a high potential hazard rating:

1. The substance shall be exposed to air only when it is used in a properly operated fume hood.

2. Appropriately impermeable gloves should be worn

3. Hygiene and work practices should prevent any bodily contact with the substance.

3.2 Chemical Handling and Storage

Chemicals can be hazardous unless properly handled. Serious skin and eye irritations and damage to clothing can result from needless spills and sprays. Toxic materials can cause severe illness, even death; all chemicals, especially new compounds, the toxicity of which has not yet been determined, should be assumed to be highly toxic until demonstrated otherwise. Flammable gases, liquids and solids can cause fires and develop into explosive mixtures.

Never transport chemical reagents on stairways where a slip or trip could result in serious exposure. Use elevators only with proper secondary containment, (e.g. rubber bucket or lab cart).

Before working with any chemical, it is essential to know its properties. The properties of known reaction products, intermediates or even possible reaction products should be ascertained before work begins (see section *3.1*). In exploratory research work, only very small quantities of chemicals should be employed. Larger amounts may be used after the initial work has been successfully completed and the reaction rates and the properties of the reaction products have been established.

Hazardous chemicals include, in addition to flammable materials, those substances that are toxic, corrosive or reactive. It must be recognized that a material, which by itself is comparatively harmless, can become very hazardous under conditions of use and under conditions to which it may be subjected accidentally--as in fires.

***** Pour acids into water *slowly* while agitating. *Never pour water into acid.*

***** Hydrofluoric Acid (HF) has special risks and requires extra safety precautions and procedures. Consult the Safety Office HF Standard before working with HF.

***** Stoppers should be held out of contact with anything but air while pouring from a bottle and chemicals should be flushed off a bottle before returning it to a rack. Chemicals should be

transferred or added while holding the receiver over a sink. *Never* return unused chemicals to stock bottles.

***** To reduce the risk of accidental breakage by service personnel, do not store glass bottles of chemicals on floor

General Chemical Storage Recommendations:

- Chemicals should NEVER be alphabetized unless they are segregated by hazard class first.
- In general, high hazard chemicals should be in separate cabinets, and organic and inorganic materials should be segregated from one another.

3.2.1 Inventory Control

The *person in charge* of a laboratory should compile an inventory list, including purchase and expiry dates, of all chemicals in the laboratory. As an absolute minimum, the chemical stocks should then be reviewed and expired or deteriorated chemicals must be discarded in accordance with disposal regulations.

3.2.2 Labelling

All containers of chemicals, including temporary containers, must have legible labels attached to them identifying both the contents and the type of hazard presented by the contents.

3.2.3 Material Safety Data Sheets

The Material Safety Data Sheet, or MSDS, contains important information about the controlled product you are using.

MSDS Availability

Every controlled product in your work/study area must have an associated MSDS readily available. The MSDS must be able to be accessed by all personnel that work with, or near the controlled product. An MSDS may be kept in either a hard (i.e., paper) or soft (i.e., electronic) format.

Hard copies must at all times be;

1. Visible, and
2. Accessible.

Soft copies must be accessible through a computer to employees/students in the area where the controlled products are stored or used.

Whether the MSDS is a hard or soft copy it must not be older than 3 years.

Maintain your MSDS collection as follows:

Laboratories/Shops/Studios

- Hard copies must be maintained for:
    - Any controlled products that are kept out in the open or on a bench-top, and
    - Controlled products that are present in:
        - a pipe;
        - a piping system including valves;
        - a process vessel; or
        - a reaction vessel

- Soft copies may be maintained for all remaining controlled products

Controlled product storage areas

- Hard copies must be maintained for storage areas with 10 or fewer controlled products
- Soft copies may be maintained for storage areas with over 10 controlled products

Controlled product dispensing areas

- Hard copies must be maintained for all controlled products dispensed in the area

3.2.4 Containers

Containers must be compatible with their contents, inspected regularly, and disposed of, if damaged or deteriorated. Chemicals should be dated when purchased, and again when the container is opened. Non-original containers must also be dated. Containers should be kept securely closed, with chemicals requiring venting being stored only in a proper pressure-venting container. Flammable and combustible liquids must be stored in and dispensed from approved containers. Containers for storage of chemicals should be chosen with care and using guidelines in the university Safety policy.

3.2.5 Explosive Chemicals

Chemicals such as propargyl bromide, azides, picric acid, and concentrated hydrogen peroxide are potential explosives and must be restricted within the laboratory to those amounts needed for one week's work. It is imperative that all substances having an explosion hazard potential be carefully dated and monitored, and kept away from heat, light, and sources of ignition or physical damage. Many ethers form dangerously explosive peroxides upon prolonged exposure to the atmosphere. Though detection of peroxides can be easily achieved by dipping a starch iodide paper strip into the solvent being tested (the strip turning purple indicates that peroxides are present), disposal is preferred when the expiry date has passed. Soluble azides, when in contact with heavy metals, can produce heat- and shock-sensitive insoluble azide explosives. These should always be handled with care, and diluted heavily with water before disposal. Picric acid containers with less than 10 percent water content are shock sensitive high explosives, and

must not be opened or moved, but reported immediately to the Safety Office for proper disposal. Also see perchloric acid (section *4.2.5.5*). Table *9* lists some chemicals that present explosion hazards.

3.2.5.4 Oxidizing Agents

Oxidizing agents such as peroxides, nitrates, nitrites, bromates, chromates, chlorates, dichromates, perchlorates, and permanganates should be restricted within the laboratory to single small-sized containers, and stored in cabinet of non-combustible material.

3.2.5.5 Corrosive Chemicals and Perchloric Acid

Corrosives such as acids and alkalis should be restricted within the laboratory to single, small-sized containers, and stored segregated from each other and from other chemicals on corrosion resistant materials. Containers of corrosives must be set into appropriate trays or buckets when being moved or stored in case of leakage or spillage. *Perchloric acid is extremely strong, and will produce severe burns when in contact with the skin, eyes and respiratory tract.* Proper protective equipment and procedures along with required specialized equipment such as a Perchloric Acid Fume Hood must be used when handling perchloric acid. All users of perchloric acid must ensure that equipment and procedures are adequate prior to use, including prepared emergency procedures. Bottles of perchloric acid, such as commercial 70%, must be inspected monthly and disposed of if any discoloration is noted. Individual preparations of anhydrous perchloric acid, which may be unstable even at room temperature, and may spontaneously explode, must not be stored, but disposed of at the end of each day. Mixtures of anhydrous perchloric acid with organic substances constitute a severe fire and explosion hazard.

3.2.5.6 Water-Sensitive Chemicals

Quantities of potassium, sodium metals and metal hydrides, which are water sensitive, should be restricted to single, small-sized containers, and stored in fire resistant, cool, dry areas designed to prevent accidental contact with water and other incompatible chemicals.

3.2.5.7 Compressed Gases

Compressed gas cylinders can be extremely hazardous when misused or abused. Certain precautions must be observed when storing, handling, and using compressed gas cylinders in order to keep the hazards to a minimum. The uncontrolled release of a compressed gas can result in serious consequences, not only because of possible toxicity and flammability, but also because a high pressure cylinder can become a lethal missile if the cylinder valve is broken off.

Storage:

- Store cylinders in an upright position (valve end up), on a level fireproof floor.
- Fasten cylinders securely at all times.
- Keep storage area well ventilated and dry.

- Ensure no flammable substances such as oil and volatile liquids are stored in the same area.
- Separate oxygen cylinders from cylinders containing flammable gases or other combustible materials by 6m, or by a 1.5m high fire-resistant wall with a rating of at least 30 minutes.
- Store out of direct sunlight and away from other sources of heat as cylinder temperatures must not exceed 125°F.
- Separate empty and full cylinders. Clearly mark the empties "MT and date" with chalk, regulator removed and valve cap replaced.
- No smoking in the storage room or near any compressed gas.
- Remove all sources of ignition from the storage room.
- Propane tanks greater than 5 lbs. In size must be stored out of doors.

Laboratory Storage:

- Storage of cylinders in the laboratory should be restricted to those cylinders that are connected and in use.
- As soon as possible remove empty, not in use, or unnecessary cylinders from the laboratory or to storage.
- Toxic gases should be placed in ventilated storage

Note: Do not remove safety cap until cylinder is fixed into cylinder holders in the laboratory.

Handling:

- Cylinders should be transported carefully in accordance with procedure listed above
- Numbers, marks, and paint colours on cylinders identify them and must not be removed or changed. Tags attached to the cap are not a satisfactory method of identification.
- Keep the metal cap securely in place to protect the valve whenever the cylinder is not G
- Protect cylinders from damage.
- Because of their shape, smooth surface, and weight, cylinders must not be carried by hand. Cylinders are to be moved only with cylinder carts in which the cylinder is securely held by a chain.
- When cylinders must be handled by a crane or derrick, carry them in a cradle or on a suitable platform and take extreme care that they are not dropped or bumped. Do not use slings.
- If necessary, cylinders may be rolled on their bottom edge while in a nearly vertical position, but never dragged.
- Keep valve caps in place when cylinders are transported, moved, or not connected for use.
- Do not use cylinders for rollers, supports, or any purpose other than to contain gas.
- Avoid dropping cylinders or allowing them to strike violently against other cylinders.
- Handle empty cylinders as carefully as full ones; residual pressures can be dangerous.
- Do not tamper with safety devices in valves or on cylinders.
- Never refill a cylinder. This calls for specialized equipment and techniques.

- Never mix gasses in a cylinder. The next person who draws from it may unknowingly cause an explosion. If an outlet valve becomes clogged with ice or frozen, thaw with warm (not boiling) water (if gas is not water reactive), applied only to the valve. Do not use a flame.

Use and Operation:

- Use cylinders, particularly those containing liquefied gas, in an upright position and secure them firmly with chains or clamps.
- Reduce the pressure **of a compressed gas** through a **manufacturer's specified regulato**r attached to the cylinder valve.
- Ensure the threads on a regulator or union correspond with those on the cylinder valve outlet. Do not force mismatched connections.
- Use regulators and pressure gauges only with gases for which they are designed and intended. Do not use adapters or modify connectors.
- Use regulators and pressure gauges only with gases for which they are designed and intended. Do not use adapters or modify connectors to circumvent this rule.
- Open cylinder valves slowly with valve outlet directed away from all personnel.
- DO NOT EMPTY A CYLINDER COMPLETELY. This will prevent a flash-back and a possible explosive mixture.
- Never use oil or grease on valves or attachments for oxygen cylinders and never handle oxygen cylinders and apparatus with oily hands, gloves, or clothing.
- Test cylinders for leaks each time you use them. Use soapy water, approved leak - test solution or detection equipment to check for leaks, never use flame. (Figure 6)
- If leaks occur in cylinders of noxious or combustible gases, close the valve and remove the cylinder outdoors or place in fume hood and notify the Safety Office.
- Purge oxygen and acetylene lines before lighting.
- When bleeding off flammable gases, use a ground wire on cylinder valves.
- Do not use recessed top of the tank cylinders for the storage of tools or other equipment.
- Never direct compressed air or other gases toward the body.
- Exercise care to avoid injury to hands or feet. The use of safety shoes and heavy gloves is highly recommended.
- Do not use force to open or close cylinder valves; if there is a problem, notify the Safety Office.
- Use the cylinder valve for turning the gas off, not the regulator valve.
- Close the main cylinder valve as soon as it is no longer necessary to have it open.
- Before you remove the regulator make sure that the cylinder valve is closed.
- Place a trap between the regulator valve and the reactor vessel to prevent contamination when carrying out chemical reactions using pressurized gas.
- Turn off the cylinder valve and then the regulator, when your work is finished. The pressure gauges should be brought back to zero.

Hoses and Connections

- Do not use unnecessarily long hoses. If a long hose must be used, make sure it is free from kinks, and away from high traffic areas.

- Examine hoses periodically for leaks.
- Repair leaks properly and promptly.
- Store hoses in a cool place, and protect from hot objects, and sparks.
- Do not use a single hose having more than one gas passage.

***3.2.5.8 Mercury** (also see section *4.3.2*)

Use caution in working with mercury (Hg). The equilibrium concentration of Hg vapour over liquid mercury at room temperature is about 20 times the threshold toxic limit.

Metallic mercury and mercury compounds can be absorbed into the body by inhalation, ingestion, or contact with the skin, but breathing the vapour is the most common cause of mercury poisoning. Mercury is a very subtle poison, the effects of which are cumulative and not readily reversible. Short exposures to high levels of mercury can cause acute poisoning. The lethal oral dose is 1.0 to 2.0 g. Additionally, mercury and its compounds are skin irritants; a solution of as little as one part of salts in 4000 parts of water can be very irritating to the unbroken skin and has been reported to be capable of causing sensitization dermatitis.

Note that Hg is a designated substance:

"Individuals working with designated substances are required to comply with the "Designated Substances Regulations (O. Reg 490)". If you work or plan to work with these materials, an assessment of the exposure or likelihood of exposure to a designated substance in the workplace must be conducted. Contact the Security Office (2583222) to request assistance in working with any designated substance."

Bulk storage of elemental mercury should be under a layer of water and in tightly covered, thick-walled glass or preferably high-density polyethylene bottles. It is a good idea to store these bottles in secondary containers. Transfers of mercury from one bottle to another should be carried out in a hood, over a tray or pan to confine any spills.

In pouring mercury, in addition to always using funnels, one should place a basin, tray, or large beaker underneath the vessel or tube into which the mercury is being poured. This does not guarantee spill immunity, but it may at lease reduce the clean-up problem greatly. If mercury gets into the cracks of a wood or tile floor or into the pores of a concrete floor, the contamination may become so great the floor must be replaced or sealed before the lab can be safely used again; this may occur with a relatively small spill that is not properly cleaned up, but which on impact with the floor becomes dispersed that the resulting large surface area and sufficiently high vapour pressure of mercury can result in poisoning. To prevent such inconvenience, metallic mercury should be handled over impervious (stainless steel or plastic) surfaces with rims but no crevices. To prevent volatilization, the surface should not be excessively warm, i.e., not above normal room temperature (15 to 20°C).

Unsealed instruments or equipment containing elemental mercury: manometers, mercury diffusion pumps, vacuum pumps, etc.:

Manometers are used in many labs, but because of the very small surface area of mercury exposed to the atmosphere they do not pose a significant problem. Nevertheless, it is a good policy to cap the open end(s) of a manometer when it is not in use. A potentially more hazardous condition may exist with a mercury diffusion pump or where a manometer is used to continuously monitor the negative pressure produced in an evacuated chamber by a vacuum pump that is in continuous operation and that exhausts within the lab. If it is not practical to place the pump in a fume hood or run exhaust tubing to a fume hood, etc, then a feasible method of minimizing or eliminating mercury vapour release into the lab involves introducing into the system a tube or vessel containing a packing agent, which can be used as a scavenger for mercury vapour, such as activated charcoal, or Resisorb or copper turnings; copper forms an amalgam with the mercury vapour in the exhausting air or gas prior to its release into the lab environment. Because mercury is a substance with no warning properties (colourless, odourless, tasteless, etc.) the pump exhaust should be monitored regularly by exhaust air sampling; obviously this need not be done when exhausting into a fume hood or similar device.

Mercury Thermometers

Mercury thermometers are no longer allowed on campus as people tend to place them in ovens and/or break them. This could lead to possible exposure, especially if the mercury gets heated. This increases the level of vapour and level of exposure. Replace with an alcohol thermometer or a thermocouple

3.2.5.9 Cryogenic Gases

Cryogenic liquids (argon, nitrogen, helium, hydrogen and oxygen) and certain other liquefied gases are at extremely low temperatures (-60/C to -266/C). Very small amounts of these liquids produce large amounts of gas. Consult the product's MSDS for specific guidelines regarding health and safety information, personal protective equipment and emergency recommendations.

Safety precautions that must be taken with compressed gases also apply to cryogenic liquids (see compressed gas standard). There are, however, additional precautions necessary when dealing with cryogenic materials.

Contact with cryogenic materials can rapidly freeze and destroy skin tissues. If exposed:

- Contact a physician immediately.
- Remove all clothing that may restrict circulation to the frozen area.
- Flush affected area with warm, not hot, water. Water temperature should be between 40/C- 46/C. Do not use dry heat.
- Do not rub frozen body parts, before or after warming.
- Keep patient warm and resting.
- Cover thawed body part with dry sterile gauze and large, bulky protective clothing.
- Do not allow patient to drink alcohol or smoke.

Common materials such as carbon steel, plastic, and rubber may become brittle or fracture after contact with cryogenic liquids.

Storage

Cryogenic liquid containers are specially designed to reduce heat loss. This design consists of an inner container and an outer casing, which are separated by a vacuum and special insulation. This construction makes cryogenic containers more fragile than other compressed gas cylinders. For this reason cryogenic containers must be handled with extreme care:

- Use dollies for moving cryogenic containers. Avoid rolling containers by holding the neck as it is the main support for the inner portion of the container.
- Keep containers clean. Avoid contaminating them with materials which may create hazardous conditions upon contact with the cryogenic fluid or gas.
- Report all leaking or improperly set relief valves, as well as safety valves with broken seals or with any frost, ice formation, or excessive corrosion to the supplier.
- Remove the container to a remote location and contact the supplier if plugs of ice or foreign material develop in container vents or opening. Do not attempt to remove the plug.
- Vent containers with an approved safety device which permits excess gas to escape.
- Label containers clearly.
- Avoid heating or welding containers which contain a cryogen.
- Do not store oxygen with any other gases except gaseous nitrogen or gaseous carbon dioxide.
- Do not store liquid nitrogen with helium, hydrogen or oxygen.

Personal Protective Equipment

- Use protective gloves when any material that comes in contact with cold liquids and their vapors is being handled. Gloves should be loose fitting, so that they can be removed quickly if liquids are spilled into them.
- Wear safety glasses, if spraying or splashing is likely a face shield should be worn.
- Cuffless trousers should cover the top of and remain outside of boots or work shoes.

General Safety Precautions

- Use and store cryogenic materials only in well ventilated areas. Cryogenic gases are capable of displacing air necessary for respiration and causing asphyxiation.
- Never allow any unprotected part of the body to touch uninsulated pipes or vessels that contain cryogenic fluids.
- Avoid wearing clothing or jewellery (watches, rings, etc.) which may trap a cryogenic fluid close to the skin.
- Use tongs to withdraw objects immersed in a cryogenic liquid.
- Perform operations slowly to minimize boiling and splashing when charging a warm condenser or when inserting objects into a cryogenic liquid.
- Remove all combustible materials from the area, especially oil or gases when handling liquid oxygen. NO SMOKING signs should be posted.
- Change and air all clothing that has been splashed with liquid oxygen immediately. Material may absorb pure oxygen and become highly flammable.

Notes:

1. When stored as a liquid monomer.
2. Although these chemicals form peroxides, no explosion involving these monomers has been reported.
3. When stored in liquid form, these chemicals form explosive levels of peroxides without concentration. They may also be stored as a gas in a cylinder. When stored as a gas, these chemicals may auto polymerize as a result of peroxide accumulation.

3.3. Chemical Spills

3.3.1 General

Prior to work with hazardous materials:

1. Determine spill procedures from MSDS for all chemicals.
2. All employees and students handling hazardous materials are required to be trained in spill procedures.
3. Obtain proper spill kits and clean up equipment.

For a small spill that poses no immediate threat to health:

1. Notify occupants in the immediate area of the spill
2. Use spill kits to absorb and contain according to spill procedure.
3. Place material in a secure and ventilated area

For large spills or spills that pose an immediate threat to health:

1. Remove sources of ignition if possible.
2. Evacuate immediate area.
3. Activate wall-mounted fire alarm pull station located at exits.
4. Call **Security at 258 3222**

Additional Precautions for Flammable Liquids

***** Immediately remove all sources of ignition from the area.

***** Identify location of nearest fire extinguisher(s)

***** Use non-sparking tools (e.g., bronze) during clean up.

3.3.1.1 Chemical Neutralization of Acids and Bases

Effective chemical neutralization depends on the chemistry of the particular spill substance and requires an *exact identification* of the spill. Neutralization can also create heat causing boiling and spattering of the spill substance. *Never attempt neutralization unless results are certain.*

Neutralization Procedures

***** Be sure that the neutralizing agent is suitable for use on the spill substance.

***** When using neutralization kit, follow directions exactly.

***** Add the neutralizing chemical cautiously and in relatively small amounts to minimize the creation of heat.

***** Apply the neutralizer from the perimeter inward and thoroughly mix the neutralizing agent with the spilled substance until the spill has been completely neutralized. The neutralizing agent in some pre-packaged kits will change colour to indicate complete neutralization.

***** Once the spill has been completely neutralized, the substance can be disposed of in accordance with approved procedures.

Strong acids: use a weak base, e.g. soda ash (sodium carbonate)

Strong caustic: use a weak acid, e.g. acetic

Oxidizing agent: use a mild reducing agent

Reducing agent: use a mild oxidizing agent

The exact neutralizer to be used on a particular spill should be identified in advance as part of the Research Project Health and Safety Assessment (see section *3.1*).

3.3.1.2 Absorbents for Solvents or Acids and Bases

Sorbents (such as clay, vermiculite, or amorphous silica) are available in the form of loose or bulk material or in the form of pre-packaged *pillows* or pads. They have the advantage of multi-purpose use, as they can be applied to different types of liquid spills-acids, caustics, liquids, or flammable solvents. *The sorbent material used must be non-reactive with the spill substance*. Use of an absorbent does not eliminate or neutralize the potential hazard of the spilled substance.

Absorption Procedures

*****Apply the sorbent carefully from the outer edge to the center to avoid spreading the spill.

***** Avoid touching or stepping into the spill or saturated sorbent.

***** Avoid inhaling any vapors.

***** Label and dispose of contaminated sorbent in accordance with the approved procedure applicable to the hazardous substance.

After neutralizing or absorbing the spill substance, clean the contaminated area thoroughly with a non-flammable detergent and water, and mop it dry.

3.3.2 Mercury

Spilled mercury must be immediately and thoroughly cleaned up. Pools and droplets of metallic mercury can be pushed together and then collected, preferably by suction using an aspirator bulb or a vacuum in which the mercury is collected under water. Alternatively, mercury spill clean-up kits are commercially available. If mercury is suspected of remaining behind, the area may be further decontaminated by creating a chemical reaction with zinc metal producing an amylogen. NOTE: sulfur powder is used to indicate the presence of mercury only. It is not a decontamination agent.

Immediately after a spill and during clean up, the area must be closed to unauthorized persons and *No Admittance* signs posted. Since mercury can cling to clothing and other items, it is imperative that anyone involved in clean up and decontamination activities wear disposable gloves and shoe covers. Disposable mercury vapour respirators must be worn by those involved in the clean-up of large spills. When the clean-up is complete, the gloves, shoe covers, and respirator (if needed) must be disposed of and hands, arms and face thoroughly washed several times.

***** *Domestic vacuum cleaners must not be used* since they will only disperse mercury aerosols and increase contamination.

***** *Sweeping must be avoided* because it creates dust and breaks the mercury into even smaller particles that can vaporize more quickly.

***** Similarly, *compressed air must not be used* to blow mercury off equipment or clothes, because it can disperse the mercury throughout the work area.

Waste Mercury Disposal

Significant quantities of metallic mercury from spills or broken thermometers or other equipment and contaminated mercury from laboratory activities should be collected in thick-walled, high-density polyethylene bottles for reclamation. .

Rags, sponges, shoe covers, and such used in clean-up activities, and broken thermometers containing small amounts of residual mercury should be placed in a sealed plastic bag, labelled, and disposed of in a safe manner (see section 3*.4.1* below).

3.4 Chemical and Biological Waste Disposal

3.4.1 Chemical Wastes

Except for certain substances , waste or outdated chemicals in appropriate containers which are clearly labelled in accordance with specified requirements (see below) may be brought to the

Storeroom for storage and subsequent pick-up by the contractor handling waste chemical removal. However, any waste which must be kept under refrigeration or in a fume hood for safety reasons *cannot* be stored in the store room.

Packaging Instructions

Do not mix waste. Use a separate container for each waste.

1. All material must be placed in an appropriate container (container material will not be degraded by contents).Container must be sealed (leaking containers will not be accepted) and placed in secondary containment during transport.
2. Containers must be clean on the exterior and are to be labelled contents listed.
3. Liquid containers should be only 80% full.
4. Store waste bottle in a secure area (not on floor).
5. Unknown substances will be accepted (an account number is required for classification of unknown).

Labelling

All containers of waste chemical must be labelled with the following information:

1. *Mandatory information*

1.1 Scientific name(s) of chemical(s). A trade name is not acceptable.

1.2 Amount (approximate).

1.3 Department of origin.

1.4 Name of professor and student or other researcher.

2. *Desired information*

2.1 When chemical identity is known, list the Group Code.

2.2 *Unknowns*: label as *unknown*, but include any information on its probable contents.

4.0 Physical Hazards and Equipment

4.1 General

Any material, be it a chemical, apparatus, an item of furniture, or a fixture can present a hazard, start a fire, or cause injury if not properly handled. You can remove or minimize the hazard with proper handling. Some of the precautions in handling common laboratory equipment are listed below:

- Place equipment as far back from the bench edge as possible.
- All hoses carrying cooling water to an apparatus should be properly clamped.
- Apparatus may tip unless the centre of gravity is within the base area. Use ring stands properly.
- Use round-bottom glass flasks for low-pressure reactions.
- All pressure equipment should be carefully inspected before using.
- Apparatus shielding: where an operation or activity may result in implosion or explosion, laboratory apparatus must be effectively shielded, with appropriate protective equipment or barriers put in place for the protection of the workers involved, and others in the laboratory.
- Know the limitations of the equipment with respect to temperature and pressure; provide for safety pressure relief or vent line.
- Never open a pressure vessel until the internal pressure has been reduced to atmospheric pressure via a relief valve.
- Never examine a pressure gauge without shielding between you and the gauge.
- Turn compressed gas (or vacuum) lines on or off slowly and with caution.
- Always place a capillary relief valve in the system when carrying out a low pressure (vacuum) distillation.
- Use appropriate traps in vacuum systems; avoid corroding the pumps by not using corrosive gases such as halogens, SO2, HCl, etc.
- Centrifugal extractors, separators, and dryers should be equipped with an interlocking device that prevents access to the drum or basket while the drum or basket is in motion. All component parts of a centrifuge, particularly the rotor, must be maintained in accordance with the manufacturer's recommendations and records kept on the number of hours the rotor has been in use.

4.2 Glassware

- Carry tubing vertically rather than horizontally. To break tubing, scratch at the point of the desired break with a single stroke of a triangular file or glass knife; moisten the scratch and place the thumb nails against the tubing directly opposite the scratch and press while pulling hands apart. A towel should be wrapped around the tubing to protect both hands in case the tubing collapses instead of breaking. For tubing with an outside

diameter of a 1.5 cm or more, a cutting wheel or hot wire cutter should be used. The tubing end should be fire polished before using.

- When bending glass tubing, place hot glass on a wire gauze. Do not place on a painted ring stand. If handing glass to another person, make sure it is cool first.
- When inserting a glass tube into a stopper, always match stopper holes and tubing size. To avoid cutting the hands, the tubing should be lubricated with glycerol or water and held wrapped in a towel before inserting. Apply necessary force in a lengthwise direction while slowly twisting the tube. It is good practice is to hold the stopper or tubing between the thumb and forefinger and grasp the tubing close to the point of insertion.
- Protect hands with a towel when removing tubing from stopper and do not use pressure. A core borer may also be used to separate rubber and glass.
- Apparatus that can roll such as a thermometer, etc, should be placed on the bench at right angles to the edge keep it from rolling onto the floor.

- Suction flasks will collapse violently under vacuum if cracked or otherwise weakened. Tapping flasks when suction is on full is an unsafe practice. Erlenmeyer and other thin-walled flat bottom flasks are not safe for use under vacuum.
- All containers should be completely emptied and rinsed before cleaning. Organic residues can react with strong oxidizing agents.
- Pipettes with a ragged edge or shortened mouthpieces should be discarded. Plastic pipettors or a propipette should be used for toxic or corrosive materials.
- Release any vacuum from all parts of apparatus before disconnecting.
- Chipped or broken glassware should be discarded into a marked container for disposal.
- Never attempt to connect flexible tubing to glass tubing which has broken, chipped or cracked ends.
- Broken glass should be removed with a brush and dust pan or cardboard and placed in approved containers only. Absorbent cotton may also be used to pick up fine pieces of broken glass. Cotton should be held with tongs. Never use a towel to clean up broken glass.

4.3 Electrical

Electrical equipment, insulating materials and conductors must be suitable for their intended use, approved, where practicable, and handled in an appropriate manner. Warning signs must be posted outside a laboratory where, by the nature of the apparatus of experiment, an electrical hazard may exist (e.g., high voltage).

- All new electrical devices (whether purchased or donated) must be inspected by a member of the Safety Committee prior to first use in the lab.
- Avoid makeshift wiring assemblies.
- Don't use worn connecting or extension cords; replace them immediately when there is any sign of thinning or cracked insulation.
- Don't use cube taps. Use only multiple-outlet strips.
- Don't handle any electrical connections with damp hands or when standing in or near water.

- Don’t continue to run a motor after liquid has been spilled on it; turn it off immediately and allow it to dry thoroughly inside and out.
- Use only explosion proof motors and switches on operations in areas exposed to flammable vapours.
- Ground all apparatus, using either 3-prong plugs or pigtail adaptors.
- Check periodically for static accumulation, especially in high voltage situations

4.4 Machine Guarding

Where laboratory equipment or machinery has an exposed moving part or presents an in-running nip hazard which may endanger the safety of a worker, an effective guard or other device which prevents access to the moving part or pinch point shall be installed and maintained.

4.5 Fume Hoods

Fume hoods are used to reduce levels of hazardous products produced or used during experiments by confining them to an area separate from the laboratory, diluting them with large quantities of air and expelling those long distances from the building.
One must ensure that the appropriate hood is used for each specific reaction or process involving specific chemicals. This information must be provided to students by the laboratory supervisor or laboratory assistants.

4.5.6 Fume Hood Safety

1. Make sure that the exhaust blower is operating and air is entering the hood, prior to starting an experiment. All fume hoods are fitted with a VentAlert flow monitor or are alarmed in some other way..
2. Do not place your face inside the hood. Keep hands out as much as possible. Perform all work involving hazardous or volatile materials in operating fume hoods.
3. Connect all electrical devices outside of the hood to avoid sparks which may ignite a flammable or explosive chemical.
4. Note that the hood is not a substitute for personal protective equipment.
5. Always work at least 6 inches in from the opening of the fume hood.
6. Do not modify fume hood.
7. Do not use your fume hood as a storage area

8. Avoid blocking off baffle exhaust slots in any manner. Elevate large equipment "2" inches off the base of the fume hood.
9. Large pieces of equipment or numerous persons standing in front of the fume hood will cause turbulence.
10. Be aware of other room ventilation factors that may interfere with your fume hood operation, such as open doors to labs, open windows, blocked exhaust ports or heating and air conditioning vents.
11. Avoid cross drafts and disruptive air currents in front of the fume hood.
12. Use the sash as a safety shield when boiling materials or conducting an experiment with

reactive chemicals.
13. Prepare a plan of action in case of an emergency, such as a power failure, especially when using extremely hazardous chemicals or acids.
14. Work with the sash at the proper operating level as indicated by the arrows.

15. When fume hood is not in use please leave sash closed.
16. When fume hood is not in use please insure that all material is in sealed container

4.6 Autoclaves

4.6.1 Hazards

Explosions producing injury and damage are possible. The stored energy in the stream is tremendous and autoclaves differ from other steam receivers in that they have to be opened frequently, and residual pressure may not be detectable by the pressure gauge.

4.6.2 Operations

1. Written operating procedures are essential.
2. Every operator should be adequately trained in the operation of an autoclave. In particular, they should be made aware of and understand the importance of:
a. Ensuring that the autoclave is completely vented before attempting to open the door.
b. The function of all operating controls and door interlocking devices.
c. The danger of interfering with or bypassing any safety device.
d. The correct application of the locking stirrups, swing bolts or door locking mechanism.
3. An operator who has not yet acquired sufficient knowledge and experience must be kept under proper supervision by a competent person.
Quality control measures must comply with the manufacturer's recommendations. All quality control measures must be well documented
1. Mechanical: time and temperature graphs, charts or printouts, done during each cycle
2. Chemical: time/temperature and/or humidity sensitive tape, strips or pellets, done on each cycle
3. Biological: spore-laden strips or vials, done weekly or more frequently if recommended by manufacture.

4.6.3 Controls

1. Safe Working Pressure - a suitable reducing valve or other suitable automatic appliance to prevent the safe working pressure being exceeded.
2. Safety Valve - a suitable safety valve so adjusted as to permit steam to escape as soon as the safe working pressure is exceeded.

3. Accurate Steam Pressure Gauge - to indicate the pressure of the steam in the vessel.
4. Isolating Valve - one for each autoclave.
5. Interlocks between the door locking mechanism and the steam inlet valve to ensure that steam cannot be turned on unless the door is properly closed and fully locked.
6. That the door cannot be unlocked unless the steam inlet valve is closed and the exhaust valve is completely open.
7. A test cock or other equivalent device to give an audible and visual indication of internal pressure in the autoclave. This test cock has to be interlocked with the door locking mechanism, so that the test cock will be completely open before the door can start to unlock.

4.6.4 General

1. A thorough examination should be done by a Boiler Inspector as prescribed in the regulations.
2. A six-weekly check by the Maintenance Engineer(s).
- As per manufactures specification
- Check Safety Valve for intact seal. (replace if damaged or broken)
- Test Safety Valve operation. (test should be conducted at 70% of maximum rated pressure)
3. Certificates of inspection must be posted.
4. Operating procedure to be written and displayed.
5. Autoclaves with automatically opening doors have an electric guard across the doorway which prevents the closing of the door if the operator is in this danger area.
6. Check ovens periodically to ensure that the seals to the closures are in good conditions, and safety devices to prevent excessive temperatures and pressures are in working order.
7. Train all users in proper techniques and use practices.
8. Use non-sealed Pyrex containers which are designed for the temperatures and pressures of the autoclave, as liquids placed in sealed bottles or in ordinary glass bottles may rupture.
9. Be aware that if the unit is set to exhaust rapidly, as might be done for instrumental sterilization, boiling may take place in bottles of liquids, with a consequent loss of liquids into the autoclave.
10. Do not run flammable liquids or chemicals which could become unstable at the temperatures reached in the autoclave through the sterilizing cycle.
11. Post operating instructions and a list of safety practices near the autoclave for easy reference.

4.7 Ovens

Ovens are used in laboratories for baking or curing materials, out-gassing, removing water from samples, drying glassware, or in some cases providing a controlled, elevated temperature for an experiment.
Equip every oven with a back-up thermostat or temperature controller which will either control the unit or shut the oven down should the primary one fail.
Do not use a unit with only a single thermostat for long, unattended processes.
Do not use an oven to heat any material from which a toxic vapour or gas would be expected to

evolve unless provisions are made to exhaust the fumes, as would be done with a fume hood.
Do not use mercury thermometers in ovens

4.8 Refrigerators

Laboratory explosions have resulted when ordinary domestic refrigerators have been used for storage of flammable liquids, and leaking vapours have reached one of the many ignition sources within such refrigerators.

4.8.1. Approved Equipment

Refrigerators and any other equipment used to store flammable materials must be certified as such the C.S.A. testing laboratories. No attempt should be made to modify existing refrigerators or other equipment for such use.
Laboratory centrifuges, deep freeze cabinets, environmental chambers, and walk-in refrigerator chests shall be similarly protected.

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