Laboratory User Manual: Nunavut Research Institute/Environmental Technology Program

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General Lab Use Rules

1) No unauthorized or unsupervised personnel are allowed in the laboratory
2) NO Smoking, NO Eating, NO Drinking in the lab, and no storing of food or drink anywhere in the lab.
3) Safety glasses (or regular glasses) and lab gloves MUST be worn at all times.
4) No Unnecessary activity (horseplay, running, etc.)
5) Closed-toe shoes must be worn at all times (i.e. no open shoes or sandals).
6) Long hair must be tied back
7) No applying make-up, lip balm, or handling of contact lenses.
8) Lab coats also should be worn when working with chemicals or infectious materials. Other personal protective equipment and clothing may be required for certain lab work
9) Only work with chemicals or other toxic or flammable materials in a functioning fume hood
10) Keep the workspaces clean and free of unwanted chemicals, specimens and equipment. Do not leave bottles of chemicals or samples, empty or full on the floor.
11) Keep laboratory doors closed at all times
12) No children or pets allowed in the lab.
13) No Unauthorized use of equipment allowed.
14) Do not block access to emergency equipment (eye wash stations, first aid kits, etc.) or to doors and passage ways
15) Review Material Safety Data Sheets (MSDS) and container labels before moving, handling, or opening chemicals. Keep copies of the MSDS accessible at all times while working with chemicals. Work only with chemicals once you know their hazards (flammability, toxicity, and reactivity), how to handle and store and dispose them safely, and emergency procedures for spills.
16) Keep chemical containers closed when not in use so contents cannot evaporate or escape a tipped container.

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17) Label all chemical containers according to chemical contents and concentrations and store chemicals only in designated storage units. Refer to Refer to MSDS for further info on safe storage for particular chemicals.
18) Never pipette by mouth; use mechanical transfer devices
19) Report accidents and dangerous incidents to your supervisor immediately.
20) Report all spills (including water) to the supervisor immediately; clean the spill only if you are trained and able to do so.

Before Leaving the Lab Make sure to:

1) Turn off any water and any equipment used for lab work (e.g. fume hoods).

2) Turn off gas, vacuum and compression lines and heating apparatus (if in use)

3) Return unused materials, equipment and apparatus to their proper storage locations

4) Label, package and dispose of all waste material properly. **Do not dispose of chemicals down the drain.** Only dispose of chemical wastes according to guidelines and if trained to do so.

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5) Dispose of broken glass and discarded sharp objects only in designated containers.

6) Remove defective or damaged equipment immediately, and arrange to have it repaired or replaced

7) Thoroughly clean with bleach any equipment or work areas that may have been in contact with hazardous materials.

8) Discard used gloves, return other protective clothing (lab coats and glasses.) to storage locations and wash your hands thoroughly

9) Turn off lights, close and lock the door (rear and front) to the laboratory if you are the last one to leave

Eye Wash Stations

Emergency eye wash stations are located in areas where there is a risk of exposure to irritants or chemicals that could damage one's eyes. Common locations of eye wash stations include laboratories and factories.

It is crucial that a person's eyes be rinsed out immediately at an emergency eye

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wash station after coming into contact with a potentially dangerous irritant or chemical. Eye wash stations are specially designed to deliver a constant, low pressure stream of warm water directly to the eyes.

1. ***Preparing the Station for Use***

   - The caps that cover the faucets should be able to be removed quickly and easily; many eye wash stations allow these covers to come off when turning the water flow on. The water flow should be warm and not too high pressure. This is usually regulated by a valve attached to the unit.

     The person holds their eyes open and gently places both eyes over the faucets, one eye over each faucet. The water will directly touch the eyeballs, rinsing irritants and chemicals out.

2. ***Length of Rinsing Time***

   - The length of time that the eyes should be in direct contact with the water flow varies depending on the irritant or chemical that has gotten into the eye. A standard minimum of 5 minutes is recommended for mild irritations. For nonpenetrating corrosives, a minimum of 20 minutes is suggested, and for penetrating corrosives (chemicals that can go through the surface of the eye and surrounding areas), a minimum of 60 minutes is recommended.

     It is important that those who work around the emergency eyewash station are trained in its proper use and know the amount of rinsing time necessary based on the type of irritant or chemical. Therefore, those working around the station should be familiar with the chemicals used in the workplace and know which are penetrating and nonpenetrating.

     Acids are more easily rinsed out, while alkalis can be more damaging and require a longer rinsing time.

3. ***Keeping the Eyes in Contact with Rinse***

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- The person using the eye wash station should continue to hold his eyelids open with his fingers, being careful not to touch the eyeballs with the fingers. The eyes should remain in contact with the rinsing fluid for the entire rinsing time. It may feel unnatural to continue to hold the eyelids open while fluid is hitting the eyes, but it is necessary to make sure the chemicals are cleared from the eyes.

Laboratory Fume Hoods

Laboratory fume hoods are enclosed units with a sliding sash for opening or closing the hood. They are able to capture and exhaust even heavy vapors, and are preferred for all laboratory procedures that require manual handling of hazardous chemical material. When properly used and maintained, fume hoods provide good protection to the user.

The NRI/ETP laboratories are equipped with *Labconco Protector® Laboratory Fume Hoods* designed to allow users to work safely with toxic, noxious and other harmful chemicals. A copy of the user's manual must be maintained next to the fume hood at all times. Users are required to review chapters 4 and 5 of the manual (pages 21-32) before operating the fume hood, to become familiar with the various components, operating procedures, and safety features. To ensure the highest degree of protection when using the fume hood please follow these guidelines:

1. Before operating the fume hood, check to make sure that the exhaust blower is operating.
2. Allow the hood to operate unobstructed for 5 minutes before loading with materials and equipment
3. Avoid placing your head in the fume hood and keep hands out of the hood as much as possible
4. Always work as far back in the fume hood as possible. It is best to keep all chemicals and apparatus at least 6 inches inside the fume hood. Heating devices should be placed at the rear of the hood.
5. Do not obstruct the air baffle slots in the fume hood
6. Always operate the exhaust system when using heat generating equipment in the fume hood
7. Only materials being used in an ongoing experiment should be kept in the fume hood. Cluttering the hood will create air flow disturbances.
8. Segregate all clean and contaminated materials while working with the fume hood
9. When it is necessary to keep a large apparatus inside a hood, it should be placed upon blocks or legs to allow air to flow underneath.

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10. Operate the hood with the sash as low as practical. Reducing the open face will increase the face velocity.
11. Do not lean into the hood. This disturbs the air flow, and also places your head into the contaminated air inside the hood.
12. Do not make quick motions into or out of the hood, or create cross drafts by walking rapidly past the hood. Limit traffic in front of the fume hood. Opening doors or windows can sometimes cause strong air currents which will disturb the air flow into the hood.
13. Keep hood door closed when not attended.
14. Remember that sinks inside fume hoods are not designed for disposing of chemical wastes.
15. **Perchloric acid and high level radioactive materials may not be used in this fume hood**

Personal Protective Equipment

Be aware that there are hazards associated with materials commonly used in personal clothing. Cotton is highly permeable. Nylon, polyester and spandex are easily melted. Body-hugging materials such as spandex will hold spilled chemicals close to the skin. Evaluate the potential hazards of your activities and wear appropriate clothing.

Eye Protection

Eye protection is recommended at all times when working near where corrosive or toxic chemicals are used or stored, and anywhere near high-pressure, high vacuum equipment, near UV or laser light, or when carrying out work that can generate dusts, sprays or other projectiles. **NEVER WEAR CONTACT LENSES** when working with hazardous chemicals,

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unless wearing safety goggles**.** Vapours readily enter the space between the lenses and the eyes via capillary action. This makes the lenses difficult to remove. If irrigation of the eye is not performed within 15 seconds of coming into contact with certain corrosive materials, permanent eye damage is likely to occur. Depending on the protection required during a specific procedure, regular safety glasses, chemical safety goggles or a full face shield may be necessary.

Hearing Protection

It is recommended that hearing protection be worn if average noise levels exceed 85 dBA (decibels) over an 8-hour period.

Lab coats

Appropriate protective clothing (e.g., lab coats, aprons, coveralls) is required in all experimental areas where hazardous materials are handled.

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 highly toxic or infectious agents
- wear protective aprons for special procedures such as transferring large volumes of corrosive material
- remove protective clothing when leaving the laboratory
- remove protective clothing in the event of visible or suspected contamination

Hand protection

A wide variety of gloves are available to protect against chemical exposure. Because the permeability of gloves of the same or similar material varies from manufacturer to manufacturer, no specific recommendations are given here. Be aware that as a chemical diffuses through a glove, that chemical is held against the worker's hand longer and the individual may then be more exposed to the chemical than if the glove had not been worn.

- Always check to ensure the absence of cracks or small holes in gloves before each use.
- **Do not wear gloves in public areas (NRI offices and classrooms).** Remove gloves before leaving the work area and before handling such things as telephones, doorknobs, writing instruments, and laboratory notebooks.
- Gloves may be reused, cleaned, or discarded, consistent with their use and contamination.

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

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 additives used in the manufacturing process
- reaction to naturally-occurring latex proteins

Frequent handwashing, 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
- polyethylene, 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 the wearing of latex gloves should be reported to a physician when symptoms first appear.

Glove selection guidelines

Base selection of glove 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 may require the use of gloves with non-slip or textured surfaces

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- type and length of contact (e.g., occasional or splash vs. prolonged or immersion contact)
- whether disposable or reusable gloves are more appropriate

Selection, use and care of protective gloves

No single glove material is resistant to all chemicals, nor will most gloves remain resistant to a specific chemical for longer than 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 takes the chemical to seep through to 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

Guidelines for 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 reactions 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 fit properly
- ensure that the gloves are long enough to cover the skin between the top of the glove 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

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 the MSDS, glove manufacturer or permeation chart. The section on electricity is included for information purposes only, as all electrical work must be done by licensed electricians.

Hazard	**Degree of Hazard**	**Recommended Material**
Abrasion	Severe	Reinforced heavy rubber, staple-reinforced leather
	Less severe	Rubber, plastic, leather, polyester, nylon, cotton
Sharp edges	Severe	Metal mesh, staple-reinforced heavy leather, Kevlar, aramid-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*: natural, nitrile or butyl rubber, neoprene, PTFE (polytetrafluoroethylene), polyvinyl chloride, polyvinyl alcohol, Teflon™, Viton™, Saranex™, 4H™, Chemrel™, Barricade™, Responder™
Cold	Leather, insulated plastic or rubber, wool, cotton	
Heat	Over 350^{o}C	Asbestos Zetex™
	Up to 350^{o}C	Neoprene-coated asbestos, heat-resistant leather with linings, Nomex, Kevlar™
	Up to 200^{o}C	Heat-resistant leather, terry cloth (aramid fibre) Nomex, Kevlar™
	Up to 100^{o}C	Chrome-tanned leather, terry cloth
Electricity	Rubber-insulated gloves tested to appropriate voltage (CSA Standard Z259.4-M1979) with leather outer glove	
General duty	Cotton, terry cloth, leather	
Product contamination	Thin-film plastic; lightweight leather, cotton, polyester, nylon	
Radiation	Low to moderate radiotoxicity	Any disposable rubber or plastic glove

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Control of Chemical Hazards

Chemicals can gain entry into the body by:

- **Inhalation** of gases, vapours and particulate material (e.g. mists, dusts, smoke, fumes)
- **Absorption** through skin of liquids, solids, gases and vapours
- **Ingestion** of chemicals directly or indirectly 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 Flammable chemicals

Flammable and combustible liquids, solids or gases will ignite when exposed to heat, sparks or flame. Flammable materials burn readily at room temperature, while combustible materials must be heated before they will burn. Flammable liquids or their vapours are the most common fire hazards in laboratories. Refer to Section 5.4 ("Preventing Fires") for specific details on the safe handling of flammable chemicals 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 (Refer to Section 5.1, "The Fire Triangle"). Oxidizing chemicals can increase the speed and intensity of a fire by adding to the oxygen supply, causing materials that would normally not burn to ignite and 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

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

- Keep away from flammable and combustible materials
- Keep containers 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 oxidizers 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 solutions 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
- Store and handle away from incompatible chemicals
- Keep water-reactive chemicals away from potential contact 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 their expiry date

Corrosive chemicals


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

- They may damage metals, releasing flammable hydrogen gas
- They may damage some plastics
- Some corrosives, such as sulphuric, nitric and perchloric acids, are also oxidizers; thus they are incompatible with flammable or combustible material
- They may release toxic or explosive products when reacted with other chemicals
- They may liberate 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 a 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

Emergency Procedures Guide

First aid

Know how to handle emergency situations 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.

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- Locate and know how to test and operate emergency equipment, such as showers and eyewashes, in your area (Refer to Section 1.4).
- Learn first aid: Contact Environmental Health and Safety for a schedule of CSST (Commission de la santé et de la sécurité du travail)-approved workplace first aid and CPR (cardiopulmonary resuscitation) course dates.

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

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 is described in Section 12.1.4 below. In electrical burns, electrical current passing through the body generates heat.

Burns to the skin

First aid treatment of skin burns encompasses the following:

- If the burn is electrical in 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 off the main power switch at the electrical distribution panel.
- Dial 911 if the burn is serious. 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 the skin.
- If possible, immerse burnt surfaces in cold water for at least 10 minutes, or apply cold wet packs.
- Avoid applying lotions, ointments or disinfectants to a 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.

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

are described in Section 12.1.4 below. General first aid procedures 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 eyes with dry sterile gauze pads; apply a wet compress to the 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 between the victim and the laser.

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 sides with adhesive tape
- wounds caused by dirty, soiled or grimy objects should be examined by a physician, who will determine whether a tetanus immunization 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 physician immediately, as immunization or post-exposure prophylaxis may be required.
- If a 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 this 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.
    - Do not remove a dressing that has become soaked 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., do not cut off the blood circulation to limbs.
    - As a tourniquet completely stops the flow of blood to beyond the point of application, it should be applied only as a last resort, as in the case of a severed limb.

Needlestick injuries

Treat bleeding needle-related injuries as described in Section 12.1.2 above. Consult a physician immediately, as post-exposure prophylaxis or immunization may be required.

Chemical splashes to the skin or eyes

For splashes to the skin:

- If the splash affects a 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.
- If you are wearing contact lenses, remove them as 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.

Poisoning

As described in section 3.1, 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 an ambulance (dial 911) for serious poisoning
- 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 such as the Quebec Poison Control Centre (1-800-463-5060)
- 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 vomitus.
- always ensure that the victim receives medical attention, even if the exposure seems minor.

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Fire Prevention and Response

- **Smoking is NOT permitted in any of the NRI laboratories.**
- Unless necessary for your work, **keep flammable liquids away from heat, flame and direct sunlight**. No welding or soldering should be performed in their vicinity.
- Static charges can build up in pipes or other apparatus through which organic liquids are flowing. **Such equipment should be electrically grounded**.
- **In case flammable or explosive chemicals are spilled and/or being evaporated into the atmosphere, DO NOT switch any electrical equipment on or off.**
- Fire extinguishers are to be used to assist you in getting out safely or for fighting small fires. **Do not attempt to fight a major fire on your own.**
- All laboratories where flammable solvents are used must be equipped with an appropriate fire extinguisher.

Laboratory ires can by caused by Bunsen burners, runaway chemical reactions, electrical heating units, failure of unattended or defective equipment, or overloaded electrical circuits. Familiarize yourself with the operation of the fire extinguishers and the location of 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 the Evacuation Monitors. Once outside of the building, move away from the doors to enable others to exit.

The fire triangle

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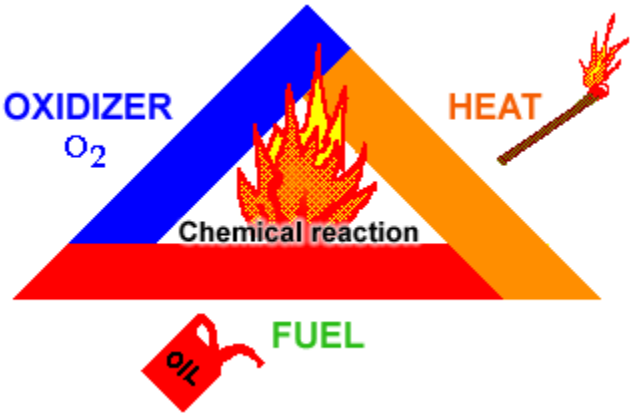
Fire cannot occur without an ignition source, fuel and an oxidizing atmosphere (usually air), the three elements that comprise what is called the "fire triangle":



Fire will not be initiated 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.

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 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.

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.

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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. If you do fight a fire, remember the acronym "PASS" when using the extinguisher:

- **P**: Pull and twist the locking 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.
- Be prepared to repeat the process if the fire breaks out again

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.
- Use and store flammable liquids and gases only in well-ventilated areas. Use a fume hood when working with products that release flammable vapours.
- Keep flammable solvent containers, including those for collecting waste, well capped. Place open reservoirs or collection vessels for organic procedures like HPLC inside vented chambers.
- 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. 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 spills of flammable liquids promptly.

Small fires may be fought with **appropriate fire extinguishers** or suffocated with **sand**, **water** or **cover**.

In the event of a **major fire** beyond your control:

1) **SHOUT "FIRE, FIRE, FIRE"** and **pull the nearest fire alarm (if available).**
2) Attempt to rescue persons in immediate danger. **Do not endanger yourself.**

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3) Evacuate personnel from the area. Leave fume hoods on. Close, but DO NOT lock the door.
4 Do not attempt to fight a major fire on your own.

Fire extinguishers are to be used to assist you in **getting out safely.**

Call the Local Fire Department/Emergency Response. Give location and details. Remain available in case further information is required

Clothing Fires

STOP (where you are), **DROP** (to the floor) and **ROLL** (to smother the flames). Shout for help. Avoid using fire extinguishers on people except in extreme emergencies. If you must use a fire extinguisher on a person, **DO NOT** aim at the face. **To avoid spreading the fire to the entire area, DO NOT proceed to the shower until the flames have been extinguished (unless very close to the shower).** After the fire has been extinguished, go to the nearest shower or hose and cool the burned areas with water. Seek medical attention.

Responding to Chemical Spills

Flammable and toxic liquids

- If you can do so without putting yourself at risk, immediately shut off all potential ignition sources

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- If fire occurs, alert everyone present and extinguish all flames. If the fire cannot be controlled immediately pull the nearest fire 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 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.

Corrosive liquids

- Alert everyone present. If vapors 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 neutralizing an extensive corrosive spill. Respiratory protection is required if the liquid releases corrosive vapour or gas.
- Pour the required neutralizing or adsorbing material around the perimeter of the spill, then carefully add water and more neutralizing material to the contained area. Carefully agitate to promote neutralization.
- Use pH paper to verify that all contaminated areas are neutralized and safe to wipe up.
- If an adsorbent (eg. spill control pillows) is used instead of a neutralizer, scoop up the absorbed spill, place it in a plastic bag, seal it, 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.

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 articulate) filter vacuum. For spills containing fine dusts, an air-purifying respirator with dust filters is recommended, as are gloves, protective goggles, and a lab coat.

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.

Gases

In the event of the release of a corrosive gas (e.g. chlorine) or gases that are absorbed through the skin (e.g. hydrogen cyanide), a complete chemical resistant suit and a self-

contained breathing apparatus are required. There is no practical means of absorbing or neutralizing a gas - the leak must be corrected at the source.

Mercury

If a small amount of mercury is spilled (e.g. broken thermometer), use an aspirator bulb or a 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 areas, sprinkle sulphur powder 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.

Labeling and Storage of Chemicals and Samples

Chemical Labeling

Labeling

Labels alert people to the dangers of the product and basic safety precautions. It is imperative that all containers in laboratories are clearly identified. Any hazardous material, whether in transit, storage, or use, must be labeled. A label may be a mark, sign, stamp, device, sticker, ticket, tag, or wrapper and must be attached to, imprinted, stenciled, or embossed on the container of the controlled product.

Containers used to store chemicals used in the NRI labs must be properly labeled with permanent marker to include the following information:
-full name of the chemical contents (including concentration in %). Abbreviations and chemical symbols are insufficient.
-date when the chemicals were brought to the NRI laboratory
-owner/user's full name, affiliation, and contact information

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If decanting chemicals from a larger vessel into a smaller one, the new vessel must be properly labeled with the above information.

The requirements for laboratory samples that are intended to be used in a laboratory immediately (same day) and solely by that person who prepared them include:

- the samples must be clearly identified;
- a description of sample's contents must be readily available (e.g., noted in a lab book); and
- Material Safety Data Sheets for the sample must be readily available.

Laboratory samples that must be transported outside of a laboratory (e.g., sent elsewhere for analysis), must have a label affixed to it that contains the following information:

- product identifier (product name)
- owner's name (name of Principal Investigator who prepared the sample)
- lab number and building
- emergency telephone number

General Storage Guidelines

- Do not block access to emergency safety equipment such as fire extinguishers, eyewashes, showers, first aid kits or utility controls such as breaker boxes or gas shut-off valves
- Avoid blocking exits or normal paths of travel: keep hallways, walkways and stairs clear of chemicals, boxes, equipment and shelf projections
- Ensure that the weight of stored material does not exceed the load-bearing capacity of shelves or cabinets
- Ensure that wall-mounted shelving has heavy-duty brackets and supports and is attached to studs or solid blocking. Regularly inspect clamps, supports, shelf brackets and other shelving hardware
- Arrange items so that they do not overhang or project beyond the edges of shelves or counter tops
- Do not stack materials so high that stability is compromised
- Leave a minimum of 18 inches (45.7 cm) of clearance between sprinkler heads and the top of storage
- Use a safety step or stepladder to access higher items; never stand on a stool or a chair

Ergonomics

- Store frequently used items between knee and shoulder height

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- Store heavy objects on lower shelves

Chemical Storage

- Store hazardous chemicals in an area that is accessible only to authorized laboratory workers
- Minimize quantities and container sizes kept in the lab
- Do not store chemicals in aisles, under sinks or on floors, desks or bench tops
- Store chemicals away from sources of heat (e.g., ovens or steam pipes) and direct sunlight
- Never stack bottles on top of each other
- Do not store chemicals above eye level/shoulder height
- Store larger containers on lower shelves
- Store liquids inside chemically-resistant secondary containers (such as trays or tubs) that are large enough to hold spills
- Store chemicals inside closable cabinets or on sturdy shelving that has 12.7 mm-19 mm (½ - ¾ inch) edge guards to prevent containers from falling
- Ensure that chemicals cannot fall off the rear of shelves
- Store chemicals based on compatibility and not in alphabetical order (refer to Table 3 and Table 4 below). If a chemical presents more than one hazard, segregate according to the primary hazard
- Designate specific storage areas for each class of chemical, and return reagents to those locations after each use
- Store volatile toxic and odorous chemicals in a way that prevents release of vapours (e.g., inside closed secondary containers, ventilated cabinets, paraffin sealing)
- Store flammables requiring refrigeration in explosion-safe or lab-safe refrigerators
- Label reactive or unstable chemicals (e.g., ethers) with the date of receipt and the date opened
- Inspect chemicals weekly for signs of deterioration and for label integrity
- Dispose of unwanted chemicals promptly through the Waste Management Program
- Keep inventory records of chemicals, and update annually
- Avoid storing chemicals in fume hoods. They interfere with the air flow, clutter work space and could potentially spill into cup sink drains.
- Avoid storing chemicals on bench tops.
- Properly store or dispose of all hazardous materials before leaving the workstation.
- Avoid storing chemicals under sinks.
-

Flammable liquid storage cabinets

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

- Use NFPA or UL approved flammable liquid storage cabinets
- Keep cabinet doors of the cabinet closed and latched
- Do not store other materials in these cabinets

Chemical compatibility

The storage scheme outlined in Section 4.6 below ("Chemical Segregation") may not suffice to prevent mixing of incompatible chemicals. Certain hazardous combinations can occur even between chemicals of the same classifications. **Table 3** shows common examples of incompatible combinations:

Table 3 - *Examples of incompatible combinations of some commonly used chemicals*.

CHEMICAL	Keep from contact with:
Acetic Acid	chromic acid, nitric acid, hydroxyl compounds, perchloric acid, peroxides, permanganate
Acetylene	chlorine, bromine, copper, fluorine, silver, mercury
Alkali Metals (e.g. Sodium)	water, chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia, Anhydrous	mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium Nitrate	acids, metal powders, 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 powders, 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
Hydrofluoric 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 acid, 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.)

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 Table 3. Note that this is a simplified scheme and that 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

- Store in grounded flammable liquid storage cabinet
- Separate from oxidizing materials

Examples:

- Acetone
- Ethanol
- Glacial acetic acid

Acids

- Store in cabinet of non-combustible material
- Separate oxidizing acids from organic acids
- Separate from caustics, cyanides, sulfides

Examples:

- Nitric acid
- Hydrochloric acid
- Sulphuric acid

Water reactive chemicals

- Store in cool, dry location
- Separate from aqueous solutions
- Protect from fire sprinkler water

Examples:

- Sodium
- Potassium
- Lithium

Non-flammable solvents

- Store in cabinet
- Can be stored with flammable liquids
- Separate from oxidizing materials

Examples:

- Carbon tetrachloride
- Ethylene glycol
- Mineral oil

Caustics

- Store in dry area
- Separate from acids

Examples:

- Ammonium hydroxide
- Sodium hydroxide
- Potassium hydroxide

Oxidizers

- Store in cabinet of non-combustible material
- Separate from flammable and combustible materials

Examples:

- Sodium hypochlorite
- Benzoyl peroxide
- Potassium permanganate

Non-oxidizing compressed gases

- Store in well-ventilated area
- separate physically from oxidizing compressed gases

Examples:

- Nitrogen
- Hydrogen
- Carbon Dioxide

Oxidizing compressed gases

- Separate physically from flammable compressed gases

Examples:

- Oxygen
- Chlorine
- Nitrous oxide

Non-volatile, non-reactive solids

- Store in cabinets or open shelves with edge guards

Examples:

- Agar
- Sodium chloride
- Sodium bicarbonate

Summary of general characteristics and procedures for handling and storage of WHMIS-controlled products.

Class and Symbol	Characteristics	Precautions
Class A Compressed Gas 	• Gas inside cylinder is under pressure • The cylinder may explode if heated or damaged • Sudden release of high pressure gas streams may puncture skin and cause fatal embolis	• Transport and handle with care • Make sure cylinders are properly secured • Store away from sources of heat or fire • Use proper regulator
Class B Flammable and Combustible Material	• May burn or explode when exposed to heat, sparks or flames • Flammable: burns readily at room temperature	• Store away from Class C (oxidizing materials) • Store away from sources of heat, sparks and flame

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	• Combustible: burns when heated	• Do not smoke near these materials
Class C Oxidizing Material 	• Can cause other materials to burn or explode by providing oxygen • May burn skin and eyes on contact	• Store away from Class B (flammable and combustible) materials • Store away from sources of heat and ignition • Wear the recommended protective equipment and clothing
Class D Poisonous and Infectious Material  **Division 1:** Materials Causing Immediate and Serious Toxic Effects	• May cause immediate death or serious injury if inhaled, swallowed, or absorbed through the skin	• Avoid inhaling gas or vapours • Avoid skin and eye contact • Wear the recommended protective equipment and clothing • Do not eat, drink or smoke near these materials • Wash hands after handling
Class D Poisonous and Infectious Material  **Division 2:** Materials Causing Other Toxic Effects	• May cause death or permanent injury following repeated or long-term exposure • May irritate eyes, skin and breathing passages: may lead to chronic lung problems and skin sensitivity • May cause liver or kidney damage, cancer, birth defects or sterility	• Avoid inhaling gas or vapours • Avoid skin and eye contact • Wear the recommended protective equipment and clothing • Do not eat, drink or smoke near these materials • Wash hands after handling
Class D Poisonous and Infectious Material	• Contact with microbiological agents (e.g., bacteria, viruses, fungi and	• Wear the recommended protective equipment

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 **Division 3:** Biohazardous Infectious Materials	their toxins) may cause illness or death	and clothing • Work with these materials in designated areas • Disinfect area after handling • Wash hands after handling
Class E Corrosive Material 	• Will burn eyes and skin on contact • Will burn tissues of respiratory tract if inhaled	• Store acids and bases in separate areas • Avoid inhaling these materials • Avoid contact with skin and eyes • Wear the recommended protective equipment and clothing
Class F Dangerously Reactive Material 	• May be unstable, reacting dangerously to jarring, compression, heat or exposure to light • May burn, explode or produce dangerous gases when mixed with incompatible materials	• Store away from heat • Avoid shock and friction • Wear the recommended protective equipment and clothing

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Managing Laboratory Wastes

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. Recent pricing arrangements with suppliers have greatly reduced the benefits of purchasing chemicals in large volumes. Also, there is little need to store large quantities of chemicals, as orders are generally shipped the day after an order is received.
- *Do not accept donations of materials* that you don't plan to use. Visiting researechers often unload unwanted reagents by donating them to the NRI/ETP laboratories, which eventually transfers the cos and liability of disposal to NRI/ETP.
- *Substitute hazardous experimental materials* for non-hazardous ones. For example, use aqueous-based, biodegradable scintillation fluids whenever possible.

Sharps

Sharps are defined as any material that can penetrate plastic bags: examples include syringe needles, scalpel blades, glass and plastic pipettes, disposable pipette tips, etc.

Contaminated sharps

- 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) and the name of the Principal Investigator.
- Discard containers of sharps contaminated with infectious materials into biomedical waste containers as per the procedure for Infectious Laboratory Waste (Section 6.3.2.2).
- Discard containers of sharps contaminated with radioactive materials as per the procedure for solid radioactive waste (Section 6.3.4.1)

Non-contaminated sharps

- Label a puncture-proof container (wide-mouth plastic bottle or a heavy-duty cardboard box lined with plastic) with the word "SHARPS", and the name of the Principal Investigator.

- Accumulate in the designated container, without overfilling.
- When full, close and seal the container and place it beside the regular garbage receptacle for pickup by the cleaning staff.

Broken glassware (uncontaminated)

- 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 the cleaning staff.

Empty chemical reagent bottles

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