CHULABHORN GRADUATE INSTITUTE CHEMICAL LABORATORY SAFETY MANUAL

EMERGENCY CONTACTS

Any immediate threat to life: **0-2576-6081 (Chulabhorn Hospital)**

Safety questions:

CGI Laboratory Safety Sub-Committee
0-2553-8555 ext. 8962, 8812
or from an internal phone (59)8962, 8812
charnsak@cri.or.th

CGI Safety Officer
0-2554-1990 ext. 2118
or from an internal phone (49)2118
utsaniphon@cgi.ac.th

FUNDAMENTAL LABORATORY SAFETY:

1. **NEVER, NEVER WORK ALONE IN THE LABS WITH HAZARDOUS MATERIALS. NO EXCEPTIONS.**
2. **ALWAYS, ALWAYS WEAR SAFETY GLASSES when in the laboratories. NO EXCEPTIONS.**
3. **ALWAYS, ALWAYS WEAR A LAB COAT AND COVERED SHOES when working with chemicals. NO EXCEPTIONS.**
4. **ALWAYS, ALWAYS USE APPROPRIATE GLOVES whenever dealing with potentially toxic liquids. NO EXCEPTIONS.**
5. **NEVER, NEVER EAT OR DRINK IN THE LABS (this includes your desk)! NO EXCEPTIONS. USE THE COMMONS ROOM FOR MEALS AND SNACKS.**

USE OF CHEMICALS AND CHEMICAL STORAGE:

6. **Carefully read material safety data sheet (MSDS) before use of chemicals**
7. **DO NOT STORE too many solvent bottles and solids bottles AT YOUR BENCH. Use your justification or consult your supervisor**
8. **ALL Chemicals MUST BE DATED AND INITIALED by the person who receives and opens them. Always LABEL ANYTHING that you put in a refrigerator with *your name, date, and contents!* Always label any vial or container that you create with your name date and contents!! (not just your lab notebook page).**
9. **Double bottle volatile odiferous compounds, ESPECIALLY if stored in a refrigerator or freezer. Old bottles of ethers (including THF) opened for more than 6 months may contain explosives. Test for peroxides before disposal.** (See Potassium Iodide Indicator on page 13)
10. **NEVER return any liquid to the bottle after removing it from the bottle. The preferred means of removing liquids is to pour into a beaker or flask. Only clean, unused disposable pipets may be used for small amounts of solvent removal directly from the bottle. When in doubt, use a new pipet.**

EXPLOSIVES, CARCINOGENS, SPECIAL RISKS

11. **NEVER store fuels and oxidizers together. Organic liquids and solids are potential fuels. Oxidizers include oxidizing gases (halogens, oxygen), oxidizing liquids (hydrogen peroxide, organic peroxides, nitric and sulfuric acids), and oxidizing solids (nitrate, perchlorate, permanganates, and chromates).**
12. **NEVER make any explosive or energetic material on a scale larger than 500 mg and if possible under 100 mg. Confer with your supervisor BEFORE any such synthesis. Store explosives and energetic materials in the designated secure explosives metal storage box.**
13. **Known carcinogens especially volatile one, such as benzene and CCl_4, must be used ONLY in the hoods with gloves. These bottles MUST be used and stored only in the hoods! They are never to be opened on desk tops. In general, consider using alternatives such as hexane, toluene, acetone, acetonitrile, dichloromethane, or THF.**
14. **CONSULT YOUR SUPERVISOR Before using Hazard chemical substance / acute toxic material** such as cyanide.

WASTE AND DISPOSAL

15. **DO NOT put anything down the drain that you wouldn't want in YOUR OWN DRINIKING WATER. Organic liquids (except ethanol, methanol and acetone), any halogenated liquids, and most metal salts MUST NOT BE PUT DOWN THE DRAIN. If you aren't sure, ASK!**
16. **Waste Solvent Containers MUST NOT BE LEFT OPEN. Do not leave funnels in open containers, even in the hood.**

EQUIPMENT, ELECTRICITY, FLOWING WATER

17. **NEVER take apart any equipment with the power cord still plugged in. Beware of electric capacitors and condensers even after unplugging.**
18. **All tubing connections to running water MUST (a) be wired or hose clamped to any condenser or connector, and (b) be connected to a 6 inch piece of copper tubing wired tight to the tubing that goes into the sink to secure the outflow deep into the drain.**
19. **ANY glass container that will be put under vacuum (dewars, rotavap, etc.) MUST BE TAPED WITH ELECTRICIAN'S TAPE OR COVERED WITH PLASTIC MESH to prevent shrapnel. Glassware can develop small, hard to notice "star cracks" from point impacts and those can lead to implosions under vacuum.**

GUIDELINES FOR EMERGENCY PROCEDURES

1. **Alert other people!**

2. **Injuries:**

   a. Get medical attention immediately. If necessary ,call 0-2576-6081 (Emergency Department, Chulabhorn Hospital)

   b. Answer all operator questions thoroughly and completely.
   Inform the operator what chemical hazards are involved in the incident.

   c. If providing first aid:
   Ensure caregiver safety is not in jeopardy
   Caregiver should be knowledgeable in treatment methods and associated hazards.

   If you don't know how to treat an injury, do not treat the injury!

3. **Serious wounds**

   Serious wounds should only be treated by a doctor.

4. **Small burns**

   Small burns should be treated with cold water or ice for a minimum of 5 minutes –
   most burn damage is the result of burning continuing after the initial exposure to heat.
   Do not apply oils or powders.

5. **Inhalation of noxious/toxic gases**

   If inhalation of noxious/toxic gases is suspected, quickly remove the victim from the area into fresh air and call Safety officer (49)2118 (from campus phones) or 0-2554-1990 ext.2118 from all other phones, In case of severe or life –threatening event, call 0-2576-6081. Provide fresh air by open window.

6. **Ingestion of poisonous chemicals**

   If poisonous chemicals have been ingested, call Safety officer (49)2118 (from campus phones) or 0-2554-1990 ext.2118 from all other phones and seek medical help immediately. Do not induce vomiting unless directed by medical personnel.

7. **Skin contact with aggressive chemicals**

   Use the safety shower to wash the affected area for 15 minutes.
   Contaminated clothing should be removed immediately and minimize personnel in affected area.

8 . **Eye contact with laboratory chemicals**

   Use an eyewash station to rinse copiously with water for 15 minutes.

9. **Bleeding and blood borne pathogens**

   Care should be taken when dealing with blood and bodily fluids. Blood borne pathogens (e.g., HIV and Hepatitis) can live in blood for weeks. The best person to clean up the blood is the person who bled. Otherwise, an individual trained in the handling of blood borne pathogens should be responsible for

cleaning up the blood. Should you decide to perform the cleanup; secure the area, wear gloves and eye protection, contain cleanup materials in plastic bags, disinfect the area with bleach, and dispose all materials according to proper procedures. Contact Safety officer (49)2118 (from campus phones) or 0-2554-1990 ext.2118 (from all other phones) for cleanup contact assistance.

10. Accident reporting

All injuries and/or accidents must be reported. Contact the Safety officer, (49)2118 (from campus phones) or 0-2554-1990 ext.2118 (from all other phones).

11. Chemical spill cleanup

a. Personal safety

Wear appropriate personal protection (lab coats, gloves, boots, goggles, respirator, etc.) as needed. Spill kits are placed at designated locations in the building. Familiarize yourself with the storage locations and contents.

b. Containment of the spill

For solvents, be sure to eliminate potential sources of ignition. Close lab doors and windows to enable laboratory chemical hood exhaust to ventilate the area. Gently place absorbent pads on the spill. Allow spill pads to absorb the spill.

c. Cleanup

For large spills or extremely toxic releases **call Safety officer (49)2118 (from campus phones)** or 0-2554-1990 ext.2118 (from all other phones**) and evacuate the area by activating the fire alarm pull box**. Place the spill absorbent into a plastic bag or other appropriate container. Seal and label the container. Contact safety officer for appropriate waste disposal

12. Fire

In the event of a large fire, the building should be evacuated by activating the fire alarm at the pull station. Pull stations are located throughout the building, primarily near exits. The fire alarm pull will set off continuous buzzers throughout the building, signal occupants to leave the building, and notify emergency response personnel.

Laboratory personnel may attempt to extinguish small fires if:

Personal safety is not in jeopardy.
Personnel are trained concerning firefighting equipment and its appropriate use.
Appropriate firefighting equipment is available.
If the fire grows or becomes unmanageable, activate the nearest fire alarm pull.
Meet the fire department to direct them to the affected area.
Never allow a fire to come between yourself and your exit path.
Never use elevator during fire.

13. Earthquakes, Windstorms, Floods, and other Natural Disastrous Events
Please refer to Precaution and Prevention of Crisis and Emergency Management Manual

EMERGENCY EQUIPMENT

1. Safety Showers and Eyewashes

Locations of safety showers and eyewashes vary throughout the building. In the lab, showers and eyewashes are in every laboratory floor.

2. Fire Alarms

Fire alarms are used to indicate mandatory building evacuation. Building evacuation may be needed in the event of: fires, chemical spills, gas leaks, and other hazards. They are located near the entrance and exit of a corridor.

3. Fire Extinguishers

Fire extinguishers are located in the hall way of each floor. Be sure to use an appropriate extinguisher for the sort of fire you have:

- **Class A Fires**

  Class A fires involve combustible solids such as paper and wood items which leave an ash. Typical extinguishers for Class A fires include water, CO_2, halon, and dry chemical. Associated problems with these fires are destructive distillation that results in flaming vapors and toxic gases, hot ash, and residue capable of re-ignition.

- **Class B Fires**

  Class B fires involve flammable liquids. Typical extinguishers include CO_2, halon, and dry chemical. Caution: Compressed gas may spread and/or worsen fire if force from the extinguisher is excessive.

- **Class C Fires**

  Class C fires involve Class A (combustible solids) and Class B (flammable liquids) fires as well as electrical equipment. Typical extinguishers include CO_2, dry chemical (may result in equipment damage), and halon. Caution: Due to possible electrical shock, de-energize the circuit prior to fighting the fire.

- **Class D Fires**

  Class D fires are those involving reactive metals (Na, K, Mg, etc.) and active hydrides (NaH, KH, etc.). Typical extinguishers and control methods include inert powder (Ansul Metal-X, sand, talc, alkali metal salts) and Metal-X extinguishers.

PROTOCOLS FOR WORKING ALONE IN THE LABORATORY

1. **When doing low-risk work, a safety partner is not required.**

2. **When doing standard work, a safety partner is required at the following times:**
    a. Weekdays before 9:00AM and after 9:00PM
    b. Any time on Saturday or Sunday

3. **When doing high-risk work, a safety partner is required at all times.**

DEFINITIONS:

Safety partner: A person who has agreed to stay and can provide aid to the researcher in an emergency (including incapacitation of the researcher). A safety partner with considerable laboratory experience is preferable, although not necessary. At a minimum, a safety partner must be able to contact safety officer (2118)/security personnel (2103).

Low-risk work: Work that poses essentially no risk of an incapacitating injury. Some representative examples include loading cold glassware into an oven, topping off a cold trap, adjusting glove box pressure, weighing low toxicity chemicals, and inspecting a reaction in progress. It does not include any manipulation of reagents and should take no more than 5 minutes.

Standard work: Work which poses a hazard that is typical of laboratory work. Some representative chemical examples include manipulating hot or evacuated glassware, performing cannula transfers, distilling or subliming compounds, transferring solid reactive or toxic compounds, obtaining spectroscopic measurements, filtering solutions, cleaning cannulae, and cleaning glassware. Some representative maintenance examples include working on a glove box, a solvent still, or a vacuum chamber.

High-risk work: Performing experiments in which highly toxic, highly pyrophoric, highly energetic, or highly reactive chemicals are a reactant, product, or likely byproduct. Also included are large-scale reactions that are highly exothermic or may rapidly produce a large volume of gas. Generally, high-risk work is considered any procedure about which you are uncomfortable or unsure of the hazards. High-risk work requires a safety partner regardless of the day or time. Before beginning the experiment, the safety partner should be informed of the experiment, its potential hazards, and appropriate actions in case of an emergency. During off hours, high-risk work requires two safety partners, one within immediate proximity and one in the lab or office areas.

PROTOCOLS FOR SAFE CHEMICAL STORAGE

a. **Segregation of Chemicals**

Chemicals should be kept separated by hazard class whenever possible to avoid unwanted reactions. Recommended hazard classes for chemical separation include: acids, bases, flammables, oxidizers, and reactives.

Physical separation (separate cabinets, storage containers, etc.) is the preferred method of storage.

b. **Flammable Liquid/Solvent Storage**

Solvent storage in a laboratory is limited. Large quantities of solvents, whether new, recycled, or waste, must be stored in non-breakable or fireproof containers. Flammable solvents stored outside of a flammable storage cabinet must not exceed a total volume of 40 liters, regardless of size of container(s).

Flammable materials must be stored in appropriate, labeled containers, in safety cans. If in a substantial amount, waste solvents should be stored in polyethylene container. Waste halogenated solvents may not be stored in metal safety cans due to corrosion.

c. **Chemical Containers**

Check the integrity of containers. Review the compatibility between the container and its contents. For example, hydrofluoric acid must not be stored in glass and some oxidizers should not be stored in plastic containers.

Laboratory safety Committee recommends using separate polyethylene container for collecting halogenated and non-halogenated waste solvents in the labs. Polyethylene container and containers should be dated upon purchase as they become brittle with age. Usage of polyethylene container and containers becomes questionable after three years. Be aware that steel safety cans frequently get plugged from solid materials and eventually rust through. Glass bottles are easily broken and are not a preferred storage container. If glass bottles are used and stored on the floor, they must be kept in secondary containment.

d. **Volatile Toxic Substances**

Volatile toxic substances shall be stored in volatile storage cabinets adequate to the purpose, or in/below hoods when cabinets are unavailable. When volatile compounds must be stored in a cooled atmosphere, explosion-proof refrigerators or cold rooms designed for this purpose must be used.

PROTOCOLS FOR CHEMICAL WASTE DISPOSAL

Management of chemical waste in the laboratory is relegated to several individuals. Specific questions regarding waste handling should be addressed to them. Check with the group members in charge of waste the first time you need to dispose of mercury, alkali metals, or any other unusually toxic or highly reactive chemical. Several guidelines to safely dispose of general chemicals follow.

a. **Regulations**

Hazardous waste must be properly and clearly labeled, containers maintained closed when not actively adding waste, and properly disposed of in a timely manner. When hazardous waste containers are stored near sinks, secondary containment must be used.

b. **Chemical waste**

Discard waste chemicals into labeled, closable (screw cap for liquids), waste containers. Solid and liquid wastes should be kept in separate containers and wastes should be further separated by their compatibility (i.e. oxidizers, acids, bases, solvents, halogenated solvents, etc.). Solvent wastes and aqueous acidic wastes can be collected separately in container, but other wastes should be collected in disposable containers. Labels should clearly identify the contents of the waste container and include the word “waste”. Examples:

If using a former chemical bottle as a waste container you must wash out the bottle, rinse 3x with water, and fill to the brim with water to displace any residual gases (exception: if you’re disposing of the same sort of chemical in the same waste container there’s no need to was). The original chemical label must be completely obscured and replaced with the word “waste,” your initials, the date, and a list of all chemicals in the bottle, with approximate percent compositions. This procedure must be followed for disposal of empty solvent bottles, except instead of writing “waste” write “empty” ,date it, and put it in the garbage.

c. **Solvent waste containers**

Solvent waste containers (polyethylene bottles) must be labeled clearly, identify the contents of the container and include the word “waste”, ex. “waste halogenated solvent”. In addition, solvent waste containers must be maintained closed when not actively adding waste.

Please note: Aqueous wastes or wastes containing heavy metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium or silver) should not be mixed with solvent wastes.

PROTOCOLS FOR SAFE HANDLING OF ELECTRICITY AND HIGH VOLTAGES

1. All laboratory personnel should know the location of electrical shutoff switches and circuit breaker switches and should know how to turn off power to equipment by using these switches.

2. Laboratory equipment (e.g. high voltage power supplies) should be correctly bonded and grounded to reduce the chances of electric shock if a fault occurs.

3. The insulation on wires can be eroded by corrosive chemicals, organic solvent vapors, or ozone (from ultraviolet lights, copying machines, and so forth). Eroded insulation on electrical equipment in wet locations such as cold rooms or cooling baths must be repaired immediately.

4. Sparks from electrical equipment can serve as an ignition source in the presence of flammable vapor.

5. Do not touch connections unless the equipment is off and the Capacitance of both the load and power supply is discharged.

6. Allow five minutes for discharge of internal capacitance of the power supply.

Use the following procedures to safely repair electrical equipment:

1) Turn off the equipment but leave it plugged in for a few seconds so that the internal capacitor has time to discharge to ground potential.

2) Unplug the equipment from the outlet.

3) If you are not well versed in electronics or if no instruction manual is available, have the device repaired in the electronics shop or by an electronics shop technician.

4) If you are working on any apparatus that is or was capable of producing high currents or high voltages, assume the voltage is still resident within the device when probing for problems. Never have more than one hand in the apparatus, keeping the other hand in your pocket.

5) Do not use a standard voltmeter with standard leads to measure high voltages because the voltmeter could explode.

PROTOCOLS FOR SAFE HANDLING OF ENERGETIC MATERIALS

Reaction Scale Consideration: The quantity of explosives within an operating area should always be the minimum required by the operation. ***Synthesis of potential explosives is restricted to 500 mg and if possible under 100 mg.*** Operational protocols and quantity need to be reviewed by Supervisor on an individual basis **in advance!**

Location & Protection: The following personal protective apparel is always required while handling explosives: Safety glasses that have solid side shields or goggles, a 100% cotton lab coat, closed-toe shoes, and heavy leather gloves if it is necessary to reach behind a shielded area.

All synthesis must be performed in a working hood with a pull-down sash and a blast shield (a polycarbonate shield of at least 0.25'' thickness) in place. The shield should be anchored so that a blast does not launch it. Handling of explosives in the dry box is allowed only when equipped with the same blast shield. Check for grounding of all electrical devices nearby and use antistatic gun to prevent static sparks. Warning signs should be posted in and near the operating area. A safety partner needs to be present during any operation.

Handling Precautions: Before handling any reactive materials, literature reports on their explosive characteristics need to be fully reviewed.

When heating is needed, use utmost caution to ensure that explosive materials are not in direct contact with the heating elements. Heating system should be monitored at all times unless equipped with override shutoff to protect against the failure of primary temperature control. Consideration should be given during design of the experiment to providing emergency cooling for the reaction vessel.

Never grind any explosive material with mortar and pestle. Never filter energetics through fitted glass. Use paper filters only.

Insensitive and low energy materials such as ammonium nitrate and dinitrotoluene (DNT) can be handled on a laboratory scale only in the pure commercial form. Synthesis involving such material is still restricted to 500 mg. When working with DNT in a gas tube, make sure that the tube is well sealed, no heating device is in vicinity and there is protection against impact.

Storage & Disposal: Separate storage must be maintained for solid explosives, liquid explosives, detonators and unknown reactive materials. **No more than 500 mg of any specific explosive material should be stored.** Warning signs need to be posted on both the storage container and cabinet. A data sheet of the explosive's identification, reactivity, fire/explosion hazard and reactivity need to be kept both in the storage place and with the safety officer. **Store explosives and energetic materials in the designated secure explosives metal storage box.**

Disposal of any explosive material should be done separately by consulting CRI Laboratory Safety Committee. Mixing with other chemicals or draining into the sink is strictly prohibited.

PROTOCOLS FOR SAFE HANDLING OF FINE PARTICULATES

Fine particles present different health issues:

1. Larger particles are relatively safe (assuming the substance is not intrinsically toxic) because large particles are captured before they enter the lungs. Particle size range: 5-10 µm
2. Smaller particles (sub-micrometer) form what is called in the public health literature as "respirable dust". These particles remain suspended in inhaled air and are deposited (some permanently) in the lungs. Particle size range: 0.1-5 µm
3. Extremely small particles (nanometer size) can be even more insidious. Not only do they remain suspended in inhaled air and are deposited in the lungs, but their size is small enough that they can move across lung tissue and enter the blood stream. This makes a hazardous material out of nano-sized particles of what otherwise might be considered "harmless".

In order to prevent exposure to fine particulates in the lab, appropriate respiratory protection should be worn. Assigned Protection Factor (APF) determines the level of the protection that a respiratory mask can provide. Recently, a respiratory manufacturer, 3M has developed disposable respiratory masks with different APF rating (4, 10, and 20 corresponding to low, moderate and high level of fine dusts, respectively). 10 and 20 APF rating respirator should be sufficient to remove fine solid particulates generated in the chemical laboratory.

PROTOCOLS FOR HAZARDOUS MATERIAL HANDLING AND STORAGE

Be aware of the specific hazards of the chemicals and equipment with which you are working. You should become acquainted with the properties of every chemical you use and understand all terminology. The Merck Index and other reference books, Material Safety Data Sheets (MSDSs), and compatibility charts are useful sources for finding hazard information. Coworkers, research advisors and Safety Personnel are also respected sources. Many hazards are outlined on the chemical container label.

All chemicals should be treated as though they were toxic. Be sure to familiarize yourself with safety risks BEFORE using a new chemical.

Working alone with hazardous materials. Do not work alone when using hazardous materials. A safety partner should be present, or at a minimum, maintain telephone contact. **Never** work alone when working with energetic materials, high pressures, quick-acting/highly toxic materials (e.g., HCN), or transfer of flammable materials (except in small quantities).

Container labels. Label all containers (including uncontaminated water) with the chemical name and appropriate hazards. In addition, it is required to have a name and date on the label. Make sure all labels are legible and use common terms (no molecular diagrams). Peroxidizable and other chemicals which may become unstable over time should be dated upon purchase and opening and consumed, discarded, or tested for peroxide formation within 6 months.

Peroxidizable compounds. Peroxidizable compounds present considerable hazards within the laboratory. Commonly used solvents such as ether, dioxane, and THF can form explosive peroxides after exposure to air. Hazards associated with peroxidizable compounds can be minimized in several ways. Store peroxide formers in an obvious location where they will not be forgotten and where they are readily accessible to Safety Personnel. Peroxide formers should be checked for peroxides every six months after opening or prior to performing distillations or evaporations.

Peroxide test strips can be purchased from Aldrich if desired. Alternatively, the presence of peroxide can be detected by the following simple potassium iodide indicator test (taken from http://www.sigmaaldrich.com/chemistry/solvents/learning-center/peroxide-formation.html)

Potassium Iodide Indicator

Add 0.5-1.0 ml of the sample solvent to an equal volume of glacial acetic acid containing about 0.1 g of sodium iodide or potassium iodide crystals. A yellow color indicates iodine formation via iodide oxidation by sample peroxide; a brown color indicates high concentration. A blank determination should be made particularly when color development is faint since iodide/acetic acid mixtures will, over time, turn a yellow - brown color due to air oxidation.

A more sensitive variation of the above method adds one drop of a saturated, aqueous starch solution to the sample solution. Starch and iodine combine to form a bright blue complex that is more easily visualized than the yellow color generated by iodine alone. Dark blue solution color would be indicative of high peroxide concentrations.

PROTOCOLS FOR SAFE HANDLING OF HEATING GLASSWARE AND EQUIPMENT

Closed systems of glassware should not be heated. Always ensure an adequate vent and use a boiling chip when heating any liquid, even water.

Bunsen burners are not to be used. Open flames in general in any laboratory are forbidden. Special exception is made for glassware/vac line repair in place. If any flame is to be used, make sure that your coworkers are not using flammable solvents. When work is completed, the glassware torch or Bunsen burner should be turned off immediately. Long hair and loose clothing pose significant hazards when using Bunsen burners.

Heating mantles are not recommended for heating flasks which contain highly flammable solvents, heterogeneous mixtures, or a reaction where the temperature needs to be carefully controlled. Heating mantles tend to form hot spots which can result in intense localized heating and/or fire. Use of a stirred silicone oil bath with temperature control better regulates the temperature and eliminates the possibility of hot spots. The size of the heating bath must correspond to the size of reaction vessel. Mineral oil baths are not permitted.

PROTOCOLS FOR SAFE HANDLING OF PRESSURIZED AND TOXIC GAS TANKS

There are two very different hazards from pressurized gas tanks: first, any tank can become a rocket if the top valve were to be knocked off; and second, of course, toxic gases are toxic! We have different kinds of gas tanks in the lab; it's important to be aware of what you are handling before doing anything with it. ***For tanks of toxic gases at high concentrations (e.g., carbon monoxide), you should have a toxic gas indicator (purchased from Fisher Scientific, for example) for that gas attached outside of the hood in which it is being used.***

When you transport a pressurized cylinder, you must use a dolly cart. The tank must be secured to the cart by a chain. ***All tanks being moved MUST have a steel cap fully screwed on to the top.*** The tank should never be stored on the dolly. After relocation it must always be secured by a strap or chain ***above*** its center of mass. All stored gas tanks should be shut off at the tank valve on the top of the tank and capped. Stored gas tanks should not have a regulator left on them.

Each gas tank needs to have an appropriate regulator – not all regulators are appropriate for all types of gases. You can identify the type of the regulator you need by looking at the number (e.g., CGA 330) on the gas tank. The regulator should be tightly screwed into the tank threaded receiver piece. Some gas tanks in the laboratory contain toxic gases and cannot be permitted to leak. You can check for leaks of connections between the tank and regulator when the tank valve is open but the valve on the end of the regulator is shut.

All experiments involving toxic gases must vent into the hood. ***After completion of an experiment using a gas tank, always close the tank valve on the top of the tank.*** Wait until all residual gas in the regulator has had time to escape out the regulator before removing the regulator. This will minimize toxic gas exposure for yourself and your lab mates.

PROTOCOLS FOR SAFE HANDLING OF SHARPS

Sharps, including but not limited to, syringes with or without needles, razor blades, and Pasteur pipettes (but NOT broken glass), require disposal in a sharps container. Note Do not over fill the sharps container.

PROTOCOLS FOR SAFE HANDLING OF ULTRASONIC EQUIPMENT

Exposure to ultrasound (i.e. beyond ~18 kHz) is inaudible and ultrasound conducted through the air is not known or expected to have any significant deleterious effect. *Audible* sounds, on the other hand, at high volume can produce a variety of effects, including fatigue, headaches, nausea and tinnitus. People typically experience physical pain at *higher* intensities than those at which damage to hearing begins to occur, so it's worth being aware of chronic loud noise.

When ultrasonic equipment is operated in the laboratory the apparatus may be enclosed in a 2-cm thick wooden box or in a box lined with acoustically absorbing foam or tiles to substantially reduce acoustic emissions (most of which are inaudible). While typical ultrasonic devices are unlikely to produce sufficient audible output to cause any of the symptoms listed in the preceding paragraph, such damping equipment will improve the quality of the lab environment. Ear plugs are a more versatile alternative to a muffler and should be used whenever working near anything producing high-volume sound, especially for extended periods.

Direct contact of the body with liquids subjected to high-intensity ultrasound of the sort used to promote chemical reactions should be avoided. Under sonochemical conditions, cavitation is created in liquids, and it can induce high-energy chemistry in liquids and tissues. Cell death from membrane disruption can occur even at relatively low acoustic intensities. Never immerse your hand or fingers in an ultrasonic bath or sonicated liquid: it can kill the basal cells in your fingernails quickly.

Exposure to ultrasonically vibrating solids, such as an acoustic horn, can lead to rapid frictional heating and potentially severe burns. Never touch an energized ultrasonic horn: it can burn you in a second if you push against it.

PROTOCOLS FOR SAFE HANDLING OF VACUUM SYSTEMS

Evacuated glassware poses a significant implosion hazard, which includes the potential of abruptly releasing glass shrapnel and the contents of the container. Evacuated glassware should not be exposed to local overheating as it can weaken the glass and cause an implosion.

a. **Desiccators**

Utmost caution is to be employed when evacuating desiccators. Inspect for defects/cracks and discard if any are found. Implosion protection must be provided without impairing visual inspection. This is often accomplished by wrapping with tape in a grid pattern that leaves the contents visible while guarding against flying glass should the vessel implode. Handle cautiously.

b. **Flasks**

Never evacuate ordinary non-vacuum flasks, especially those with flat surfaces. Erlenmeyer flasks under vacuum pose a significant implosion hazard and should never be used on a rotovap or for evaporating chromatographic fractions. Due to Dewar Flasks being continually under vacuum, they pose an implosion hazard. Dewar Flasks present an implosion hazard with the potential of abruptly releasing glass shrapnel and the contents of the container and should be handled carefully.

c. **Rotovaps**

The body of a rotary evaporator needs to be implosion protected without loss of visibility. This can be accomplished by using a plastic encased flask or by wrapping with tape in a grid pattern.

A one-liter flask is the largest that can be used effectively with most rotary evaporators. Flasks larger than one-liter pose safety risks due to possible breakage of the neck of the flask, increased bumping of liquids, and the risk of spilling large quantities of chemicals due to the possibility of a poor vacuum.

PROTOCOLS FOR SAFE HANDLING OF FLOWING WATER

All tubing connections to running water MUST be wired or hose clamped to any condenser or connector to the tubing that goes into the sink to secure the outflow deep into the drain.

Water pressure tends to increase at night when water usage in the building decreases. This is the cause of tubing popping off of condensers and why you MUST wire the tubing tight.

LABORATORY SAFETY TRAINING CHECK LIST

PRIOR to beginning any laboratory research and/or upon assignment to a research group you must :

- read through this CGI chemical safety manual.
- Pass the Exam with score at least 80%

FAMILIARIZE yourself with the location and operation of each of the following items (check off each item):

- Nearest Fire Alarm
- Other Emergency Alarms
- Location and types of fire extinguishers
- Personal protective equipment
- Hazards specific to the laboratory (lasers, cryogenics, chemical hazards, etc.)
- Safety Shower
- Eyewash
- Spill kits (including chemical spill kits, HF spill kits, Biohazard spill kits, etc.)
- Emergency Exits

Completed the "Laboratory Safety Training Checklist" and "Safety Quiz" (next page) before start any experiment.

DISCUSS with your research advisor what special hazards/precautions you will need to follow in your research. Please use the *Laboratory Safety Training* - found in your Group Safety Manual (or see attached document). Briefly outline these below:

LABORATORY SAFETY TRAINING – NEW ORIENTATION CHECKLIST, p. 1 of 2

Please use this checklist for additional laboratory-specific training.

Please check where applicable:

- ☐ Read CGI Chemical Safety Manual
- ☐ Review emergency information: Spills, Personal Injury, Fire, and Power Failure.
- ☐ Fire extinguisher
- ☐ First aid supplies
- ☐ Safety shower
- ☐ Eye wash
- ☐ Evacuation plans
- ☐ Basic Safety Rules
- ☐ Note rules with special importance for your laboratory identified by your PI.
- ☐ Identify specific areas for food consumption outside of the lab.
- ☐ Review procedures for working after hours.
- ☐ Review Waste Handling Procedures.
- ☐ Labeling
- ☐ Packaging Pick ups
- ☐ Review procedures for chemical procurement, distribution, and storage.
- ☐ Storage (acid, flammable, refrigerator, etc.)
- ☐ Personal Protective Equipment (PPE)
- ☐ Location where certain procedure(s) may be performed (e.g., mechanical ventilation).
- ☐ Waste Disposal (aqueous, solid, bio-hazardous, and radioactive)
- ☐ Review procedures for use of compressed gas cylinders
- ☐ Protective Apparel and Equipment (Personal Protective Equipment or PPE)

LABORATORY SAFETY TRAINING – NEW ORIENTATION CHECKLIST, p. 2 of 2

- ☐ Discuss when safety glasses, goggles, or face shields are required.
- ☐ Discuss any need for other protective equipment.
- ☐ Discuss selection of gloves.
- ☐ Discuss materials stored or frequently present on the floor.
- ☐ Discuss maintenance items for scientific equipment.
- ☐ Review recent incidents/accidents/injuries and how to prevent recurrence.
- ☐ Review new equipment at least annually.
- ☐ Review new procedures at least annually.
- ☐ Review results of recent inspections and how to correct problem areas.
- ☐ Review other specific safety requirements identified by the Principal Investigator for your research group. Please list them below.

I have read new orientation safety checklist

Researcher Name: _____

Researcher Signature: _____

Principal Investigator Name: _____ PI or Group

Safety Officer: _____

Date:

SAFETY QUIZ FOR NEW STUDENTS

1. When is it unsafe to work alone in the lab?

2. What kind of hazardous materials do you work with and what precautions do you need to take?

3. What precautions do you take when working with pyrophoric materials and how do you handle an accident?

4. What should you do if a chemical splashes in your eye?

5. How would you deal with a fire in the lab?

6. How do you handle a chemical spill?

7. How would you protect yourself when assembling glass & glass tubing structures?

8. What is the correct way of handling and transporting gas cylinders?

9. How do you handle waste disposal?

10. What precautions are needed when using ultrasonic horns?

11. What is the largest amount of energetic materials or explosives that you should handle and what things must you avoid in such handling?

12. What precautions should you take when handling toxic gases?