Guidelines for Laboratory Safety

Everyone in the lab is responsible for their own safety and the safety of others. Before starting any work in the lab, personnel should be familiar with the procedures and equipment being used. Lab personnel should be aware of the chemical hazards before working with them. Personnel who are unfamiliar with the hazardous material or a new procedure should consult their supervisor.

All students must read and understand the information in this document with regard to laboratory safety and emergency procedures prior to the first laboratory session. Effort has been made to address situations that may pose a hazard in the lab but the information and instructions provided cannot be considered all-inclusive.

Students must adhere to written and verbal safety instructions throughout the academic term. Since additional instructions may be given at the beginning of laboratory sessions, it is important that all students arrive at each session on time.

With good judgement, the chance of an accident in this course is very small. Nevertheless, research and teaching workplaces (labs, shops, etc.) are full of potential hazards that can cause serious injury and or damage to the equipment. Working alone and unsupervised in laboratories is forbidden if you are working with hazardous substances or equipment. With prior approval, at least two people should be present so that one can shut down equipment and call for help in the event of an emergency.

Safety training and/or information should be provided by a faculty member, teaching assistant, or staff member at the beginning of a new assignment or when a new hazard is introduced into the workplace.

MSDS information available here: http://www.

The following guidelines are recommendations for working safely in a lab:

Emergency Response

It is your responsibility to

1. Read safety and fire alarm posters and follow the instructions during an emergency
2. Know the location of the fire extinguisher, eye wash, and safety shower in your lab and know how to use them.
3. Notify your instructor immediately after any injury, fire or explosion, or spill.
4. Know the building evacuation procedures.

Common Sense

Good common sense is needed for safety in a laboratory. It is expected that each student will work in a responsible manner and exercise good judgement and common sense. If at any time you are not sure how to handle a particular situation, ask your Lab Instructor for advice.**DO NOT TOUCH ANYTHING WITH WHICH YOU ARE NOT COMPLETELY FAMILIAR**. It is always better to ask questions than to risk harm to yourself or damage to the equipment.

Personal and General laboratory safety

1. Never eat, drink, or smoke while working in the laboratory.
2. Read labels carefully.
3. Lab coats should be worn as appropriate in all laboratories.
4. Wear safety glasses or face shields when working with hazardous materials and/or equipment.
5. Wear gloves when using any hazardous or toxic agent.
6. Clothing: When handling dangerous substances, wear gloves, laboratory coats, and safety shield or glasses. Shorts and sandals should not be worn in the lab at any time. Shoes are required when working in the machine shops.
7. Keep the work area clear of all materials except those needed for your work. Coats should be hung in the hall or placed in a locker. Extra books, purses, etc. should be kept away from equipment, that require air flow or ventilation to prevent overheating.
8. Disposal - Students are responsible for the proper disposal of used material if any in appropriate containers.
9. Do not use any equipment unless you are trained and approved as a user by your supervisor.
10. Secure any dangling jewelry, restrain loose clothing, and tie back long hair that might get caught in equipment before starting work.

11. Equipment Failure - If a piece of equipment fails while being used, report it immediately to your lab assistant or tutor. Never try to fix the problem yourself because you could harm yourself and others.
12. If leaving a lab unattended, turn off all ignition sources and close the doors.
13. Never pipette anything by mouth.
14. Clean up your work area before leaving.
15. Minors or personal pets are not permitted in laboratories.
16. Food and drink should not be consumed in the lab.
17. Do not store food and drinks in laboratory refrigerators.
18. Avoid working alone in the lab. If you must work alone, make someone (such as a supervisor) aware of your location.
19. Wash your hands frequently throughout the day and before leaving the lab.
20. Do not wear lab coats, gloves, or other personal protective clothing outside of lab areas. This clothing may have become contaminated and you could spread the contamination.
21. Cell phones and use of music headphones should be avoided while working in the lab. They can be distracting and thereby increase the potential for an accident to occur. They can also become contaminated if handled while working with hazardous materials.

Electrical safety

1. Obtain permission before operating any high voltage equipment.
2. Maintain an unobstructed access to all electrical panels.
3. Wiring or other electrical modifications must be referred to the Electronics Shop or the Building Coordinator.
4. Avoid using extension cords whenever possible. If you must use one, obtain a heavy-duty one that is electrically grounded, with its own fuse, and install it safely. Extension cords should not go under doors, across aisles, be hung from the ceiling, or plugged into other extension cords.
5. Never, ever modify, attach or otherwise change any high voltage equipment.
6. Always make sure all capacitors are discharged (using a grounded cable with an insulating handle) before touching high voltage leads or the "inside" of any equipment even after it has been turned off. Capacitors can hold charge for many hours after the equipment has been turned off.
7. When you are adjusting any high voltage equipment or a laser which is powered with a high voltage supply, USE ONLY ONE HAND. Your other hand is best placed in a pocket or behind your back. This procedure eliminates the possibility of an accident where high voltage current flows up one arm, through your chest, and down the other arm.

Mechanical safety

1. When using compressed air, use only approved nozzle and never point the direction of air towards any person.

2. Guards on machinery must be in place during operation.
3. Exercise care when working with or near hydraulically - or pneumatically-driven equipment. Sudden or unexpected motion can inflict serious injury.

Chemical safety

1. Treat every chemical as if it were hazardous.
2. Make sure all chemicals are clearly and currently labeled with the substance name, concentration, date, and name of the individual responsible.
3. Never return chemicals to reagent bottles. (Try for the correct amount and share any excess.)
4. Comply with fire regulations concerning storage quantities, types of approved containers and cabinets, proper labeling, etc. If uncertain about regulations, contact the building coordinator.
5. Use volatile and flammable compounds only in a fume hood. Procedures that produce aerosols should be performed in a hood to prevent inhalation of hazardous material.
6. Never allow a solvent to come in contact with your skin. Always use gloves.
7. Never "smell" a solvent!! Read the label on the solvent bottle to identify its contents.
8. Dispose of waste and broken glassware in proper containers.
9. Clean up spills immediately.
10. Do not store food in laboratories.

Lasers safety

1. NEVER, EVER LOOK INTO ANY LASER BEAM, no matter how low power or "eye safe" you may think it is.
2. Always wear safety goggles that protect against the specific wavelength of the laser.
3. The most common injury using lasers is an eye injury resulting from scattered laser light reflected off of mountings, sides of mirrors or from the "shiny" surface of an optical table. The best way to avoid these injuries is to always wear your goggles and NEVER LOWER YOUR HEAD TO THE LEVEL OF THE LASER BEAM! The laser beam should always be at or below chest level.
4. Always use "beam stops" to intercept laser beams. Never allow them to propagate into the laboratory. Never walk through a laser beam. Some laser beams of only a few watts can burn a hole through a shirt in only a few seconds.
5. If you suspect that you have suffered an eye injury, notify your instructor or teaching assistant IMMEDIATELY! Your ability to recover from an eye injury decreases the longer you wait for treatment.
6. Do not allow any reflective materials in or along the path of the beam.

7. Post warning signs in all laser areas. If required, use a flashing light at the lab entrance to indicate when a laser is in use.
8. Consult the Laser Safety Manual for more information.

Additional Safety Guidelines

- Never do unauthorized experiments.
- Never work alone in laboratory.
- Keep your lab space clean and organized.
- Do not leave an on-going experiment unattended.
- Never taste anything. Never pipette by mouth; use a bulb.
- Never use open flames in laboratory unless instructed by lab supervisor.
- Check your glassware for cracks and chips each time you use it. Cracks could cause the glassware to fail during use and cause serious injury to you or lab mates.
- Maintain unobstructed access to all exits, fire extinguishers, electrical panels, emergency showers, and eye washes.
- Do not use corridors for storage or work areas.
- Do not store heavy items above table height. Any overhead storage of supplies on top of cabinets should be limited to lightweight items only. Also, remember that a 36" diameter area around all fire sprinkler heads must be kept clear at all times.
- Areas containing lasers, biohazards, radioisotopes, and carcinogens should be posted accordingly. However, do not post areas unnecessarily and be sure that the labels are removed when the hazards are no longer present.
- Be careful when lifting heavy objects.
- Clean your lab bench and equipment before you leave the laboratory.

Housekeeping and Decontamination

- Work areas must be kept clean and free of unnecessary chemicals. Clean the work area throughout the day and before leaving the lab for the day.
- If necessary, clean equipment after use to avoid the possibility of exposing the next person who uses it.
- Keep all aisles and walkways in the lab clear to provide a safe walking surface and an unobstructed exit. Do not block doors.
- Do not block access to emergency equipment (i.e. fire extinguishers, eyewashes, etc.), emergency shut-offs, and utility controls (i.e. electrical panels).

Accidents and Spills

See the Emergency Procedures section for detailed procedures. Do not clean up spills unless trained to do so. Supplies for cleaning up minor spills should be readily available. In case of release, promptly clean up spills using appropriate personal protective equipment (PPE).

Spill Response Equipment

Supplies for a chemical spill should include:

- An inert absorbent such as kitty litter or vermiculite or a 50/50 mixture of the two or a commercial absorbent
- A plastic (non-sparking) scoop, plastic bags for the spilled material
- Chemical resistant gloves
- Goggles
- Sodium bicarbonate to neutralize acids.

Note: All spent spill clean-up materials should be disposed of in the same manner as the spilled chemical or biological material. Spill clean-up supplies should be checked and re-stocked as necessary. Dispose of clean-up material through the waste disposal program.

Steps to Prevent Routine Exposure

- Develop and encourage safe habits
- Avoid unnecessary exposure to chemicals by any route
- Do not smell or taste chemicals
- Vent any apparatus which may discharge toxic chemicals (e.g., vacuum pumps, distillation columns) into local exhaust devices such as fume hoods
- Do not allow release of toxic substances in cold rooms or warm rooms, since these have contained, re-circulated air

Equipment and Glassware

The following guidelines for the use and care of glassware and other laboratory equipment are recommended as follows:

Glassware and Glass Bottles

- Inspect all glassware before use. Discard any broken, cracked, or chipped glassware.

- Transport all glass chemical containers in rubber or polyethylene bottle carriers when leaving one lab area to enter another. Use a cart if transporting more than two bottles.

Assembly of Laboratory Apparatus

- Firmly clamp apparatus and set up away from the edge of the lab bench.
- Only use equipment that is free from cracks, chips, or other defects.
- If possible, place a pan under a reaction vessel or other container to contain liquid if the glassware breaks.
- Do not allow burners or any other ignition sources nearby when working with flammable liquids.
- Lubricate glass stopcocks.
- Properly support and secure condensers and water hoses with clamps and wires. Be sure to direct the water hoses so that any drips that come off the hoses do not splash down onto any electrical wires.
- Position apparatus that is attached to a ring stand with the center of gravity over the base and not to one side.
- Assemble the apparatus so that burners or baths can be removed quickly.
- Use an appropriate vapor trap and confine the setup to a fume hood if there is a possibility of hazardous vapors.
- Put the setup in a fume hood whenever conducting a reaction that could result in an implosion or explosion. Keep the sash pulled down. If it is not possible to use a fume hood, use a standing shield that is stabilized and secured.

Ultraviolet Lamps

- Wear ultraviolet absorbing protective safety glasses while working with ultraviolet light.
- Protect your skin from potential burns due to ultraviolet light.
- Shield any project in which ultraviolet light is used to prevent escape of the direct beam or scattered radiation.

Personal Protective Equipment (PPE)

The most important thing to remember about protective clothing is that it only protects you if you wear it. The lab supervisor must ensure that appropriate personal protective equipment is worn by all persons, including visitors, in areas where chemicals

are stored or handled. Material Safety Data Sheets or other references should be consulted for information on the type of protective clothing required for the particular work you are performing. In general, when working in an area with hazardous materials, your skin should be covered from shoulders to toes.

Protective Eyewear

- Goggles provide the best protection against chemical splashes, vapors, dusts, and mists.
- Goggles that have indirect vents or are non-vented provide the most protection, and an anti-fog agent can be applied.
- Standard safety glasses provide protection against impact.
- Remember, prescription glasses do not provide adequate protection in a laboratory setting. Prescription safety glasses can be purchased from most opticians.
- Alternatively, safety glasses and goggles designed to fit over prescription glasses are available through commercial vendors.

Face shields

- Face shields can protect against impact, dust, particulates, and splashes to the face, eyes, and throat. However, always wear protective eyewear such as goggles underneath a face shield. Chemical vapors and splashes can still travel under and around a face shield.
- If scratches or cracks are noticed in the face shield, replace the window.

Protective Gloves

- Any glove can be permeated by chemicals. The rate at which this occurs depends on the composition of the glove, the chemicals present and their concentration, and the exposure time to the glove. If you are not certain which type of glove provides you with the protection you need, contact the manufacturer and ask for specifics on that glove.
- If direct chemical contact occurs, replace gloves regularly throughout the day. Wash hands regularly and remove gloves before answering the telephone or opening doors to prevent the spread of contamination.
- Check gloves for tears, holes and cracks.
- Butyl, neoprene, and nitrile gloves are resistant to most chemicals, e.g., alcohols, aldehydes, ketones, most inorganic acids, and most caustics.

- Disposable latex and vinyl gloves protect against some chemicals, most aqueous solutions, and microorganisms and reduce risk of product contamination.
- Leather and some knit gloves will protect against cuts, abrasions, and scratches, but not against chemicals.
- Temperature-resistant gloves protect against cryogenic liquids, flames, and high temperatures such as autoclaves.

Note: Latex gloves should not be worn if a person has or suspects a latex allergy.

Lab Coats and Aprons

- The primary purpose of a lab coat is to protect against splashes and spills. A lab coat should be nonflammable, where necessary, and should be easily removed. Other types of lab coats such as flame resistant coats are available.
- Lab coats should be buttoned when in use.
- Rubber coated aprons can be worn to protect against chemical splashes and may be worn over a lab coat for additional protection.

Shoes

- Shoes that fully cover the feet should always be worn in a lab. If work is going to be performed that includes moving large and heavy objects, steel-toed shoes should be worn.

Use of Fume Hoods

Use a fume hood for all procedures that might result in the release of hazardous chemical vapors or dust.

- Confirm that the hood is working before use by holding a tissue, or other lightweight paper, up to the opening of the hood.
- The paper should be pulled inward.
- Leave the hood "on" when it is not in active use if toxic substances are stored inside or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off."

Proper Use of Fume Hoods

- Equipment and other materials should be placed at least six inches behind the sash, preferably in the middle of the hood. This will reduce the exposure of personnel to chemical vapors that may escape into the lab due to air turbulence.

- When the hood is not in use, pull the sash all the way down. While personnel are working at the hood, pull down the sash as far as is practical. The sash is constructed of safety glass to protect users against fire, splashes, and explosions.

- Fume hood sash should be at or below 18 inches.
- Do not keep loose papers, paper towels, or tissues (e.g., Kimwipes®) in the hood. These materials can be drawn into the blower and adversely affect the performance of the hood.
- Do not use a fume hood as a storage cabinet for chemicals.

  Do not store chemicals or other items in the fume hood

- Excessive storage of chemicals and other items will disrupt the designed airflow in the hood. In particular, do not store chemicals against the baffle at the back of the hood, because this will interfere with the laminar airflow across the hood.
- If large equipment must be kept in a fume hood, raise it 1.5 inches off the work surface to allow air to flow underneath. This dramatically reduces the turbulence within the hood and increases its efficiency.
- Do not place objects directly in front of a fume hood (such as refrigerators or lab coats hanging on the manual controls) as this can disrupt the airflow and draw contaminants out of the hood.
- Keep in mind that modifications made to a fume hood system, e.g., adding a snorkel, can render the entire system ineffective. Modifications should not be done without proper authorization.
- Minimize the amount of foot traffic immediately in front of a hood. Walking past hoods causes turbulence that can draw contaminants out of the hood and into the room.

Lab Safety and Rules Signature Form

- The Lab Safety Rules are posted on UTM FS Web site [http://www. /LabSafetyRules.html]. You have to print, read and understand them before doing any work in the lab.
- By signing below you have confirm that,

  "I have read, understood and will obey all Lab safety rules as posted on the UTM FS Web or elsewhere and/or given orally".

  I have been given an opportunity to review the Lab Safety Rules and discuss my concerns with my lab Instructor and/or my supervisor before signing the above statement.

Name of Student: _____ Lab Name & Location: _____

Signature : _____ Date, Day & Time: _____

Witness by;

Name of Lab Instructor/Supervisor: _____ Date: _____.

Signature _____

Basic Guidelines for Working with Hazardous Materials

1. Working with Allergens
2. Working with Embryotoxins
3. Working with Chemicals of Moderate Chronic or High Acute Toxicity
4. Working with Substances of High Chronic Toxicity

1. Working with Allergens

A wide variety of substances can illicit skin and lung hypersensitivity. Examples include common substances such as;

- diazomethane,
- chromium,
- nickel,
- bichromates,
- formaldehyde,
- isocyanates, and
- certain phenols.

Because of this variety and the varying response of individuals, suitable gloves should be used whenever there is potential for contact with chemicals that may cause skin irritation.

2. Working with Embryotoxins

Embryotoxins are substances that cause adverse effects on the developing fetus in pregnant women. A few substances have been demonstrated to be embryotoxic in humans.
These include:

- Benzene
- Heavy Metals
- Carbon Tetrachloride
- Chloroform
- Azo dyes
- Propylene glycol
- Xylene
- Formaldehyde
- Nitrous oxide
- Toluene

Because the period of greatest susceptibility to embryotoxins is the first 8-12 weeks of pregnancy, which includes a period when a woman may not know that she is pregnant; women of childbearing potential should take care to avoid skin contact with all chemicals. The following procedures are recommended to be followed routinely by women of childbearing potential in working with chemicals requiring special control because of embryotoxic properties:

- Embryotoxins requiring special control should be stored in an adequately ventilated area. The container should be labeled in a clear manner such as the following: **EMBRYOTOXIN: READ SPECIFIC PROCEDURES FOR USE.** If the storage container is breakable, it should be kept in an impermeable, unbreakable secondary container.
- Women of childbearing potential should take adequate precautions to guard against spills and splashes. Operations should be carried out using impermeable containers and in adequately ventilated areas. Appropriate safety apparel, especially gloves, should be worn. All fume hoods, glove boxes, or other essential engineering controls should be working properly before work is started.
- Supervisors must be notified regarding all incidents of exposure or spills of embryotoxins requiring special control. Occupational Health should be consulted about any exposures of women of childbearing potential above the acceptable level (i.e. any skin contact or inhalation exposures).

3. Working with Chemicals of Moderate Chronic or High Acute Toxicity

Before beginning a laboratory operation, each worker is strongly advised to learn about the substances to be used. The precautions and procedures described in this section should be followed if any of the substances used in significant quantities are known to be moderately or highly toxic (if any of the substances used are known to be highly toxic, it is recommended that two people be present in the area at all times).

These procedures should also be followed if the toxicological properties of any of the substances used or prepared are unknown. If any of the substances to be used or prepared are known to have high, chronic toxicity (e.g., compounds of heavy metals and other potent carcinogens), then the directions and procedures described below should be supplemented with additional precautions to aid in containing and ultimately destroying the substances having high chronic toxicity. Some examples of potent carcinogens (substances known to have high chronic toxicity), along with their corresponding chemical class, are:

Alkylating Agents:

- *α -Halo Ethers*
- Bis(Chloromethyl) Ether
- Methyl Chloromethyl Ether
- *Aziridines*
- Ethylene Imine.
- 2-Methylaziridine
- *Diazo, Azo, and Azoxy Compounds*
- 4-Dimethylaminoazobenzene

Electrophilic Alkenes and Alkynes.

- Acrylonitrile
- Acrolein
- Ethyl Acrylate

- *Epoxides*
- Ethylene Oxide
- Diepoxybutane
- Epichlorohydrin
- Propylene Oxide
- Styrene Oxide
- *Sulfonates*
- Diethyl Sulfate
- Dimethyl Sulfate
- Ethyl Methanesulfonate
- Methyl Methanesulfonate
- Methyl Trifluoromethanesulfonate
- 1,3-Propanesultone
- 1,4-Butanedioldimethanesulfonate

Acylating Agents:

- β –Butyrolactone
- β -Propiolactone
- Dimethylcarbamoyl Chloride

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Aromatic Amines:

- 4-Aminobiphenyl
- Aniline
- o-Anisidine
- Benzidine
- o-Toluidine

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Organohalogen Compounds:

- 1,2-Dibromo-3-Chloropropane
- Bis(2-Chloroethyl) Sulfide
- Vinyl Chloride
- Chloroform
- Methyl Iodide
- 2,4,6-Trichlorophenol
- Carbon Tetrachloride
- Hexachlorobenzene
- 1,4-Dichlorobenzene

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Natural Products:

- Adriamycin
- Aflatoxins
- Bleomycin

- Progesterone
- Reserpine
- Safrole

Inorganic Compounds:

- Cisplatin

The overall objective of the procedures outlined in this section is to minimize exposure of the laboratory worker to toxic substances by taking all reasonable precautions. Thus, the general precautions outlined should normally be followed whenever a toxic substance is being transferred from one container to another or is being subjected to some chemical or physical manipulation. The following precautions should always be followed:

1. Protect the hands and forearms by wearing either gloves and a laboratory coat or suitable long gloves to avoid contact of the toxic material with the skin.
2. Procedures involving volatile toxic substances and those involving solid or liquid toxic substances that may result in the generation of aerosols should be conducted in a fume hood or other suitable containment device.
3. After working with toxic materials, wash the hands and arms immediately. Never eat, drink, chew gum or tobacco, apply cosmetics or contact lenses, take medicine, or store foods in areas where toxic substances are being used.

These standard precautions will provide laboratory workers with good protection from most toxic substances. In addition, records that include amounts of material used and names of workers involved should be kept as part of the laboratory notebook record of the project. To minimize hazards from accidental breakage of apparatus or spills of toxic substances in the fume hood, containers of such substances should be stored in pans or trays made of polyethylene or other chemically resistant material and apparatus should be mounted above trays of the same type of material.

Alternatively, the working surface of the hood can be fitted with a removable liner of adsorbent plastic-backed paper. These materials will contain spilled toxic substances in a pan, tray, or absorbent liner and greatly simplifies subsequent cleanup and disposal. Any material that comes in contact with toxic substances should be disposed of as a toxic substance. Vapors that are discharged from the apparatus should be trapped or condensed to avoid adding substantial amounts of toxic vapor to the hood exhaust air. Areas where toxic substances are being used and stored must have restricted access, and warning signs must be posted if a special toxicity hazard exists.

The general waste disposal procedures must be followed for these types of chemicals. In general, the waste materials and solvents containing toxic substances must be stored in closed, impervious containers so that personnel handling the containers will not be exposed to their contents.

The laboratory worker must be prepared for potential accidents or spills involving toxic substances. Lab workers must be trained in handling toxic materials and spill clean-up before beginning work with toxic substances.

If a toxic substance contacts the skin, the area should be washed with water. If there is a major spill outside of the hood, the room or appropriate area should be evacuated and necessary measures should be taken to prevent exposure of other workers. Spills must be cleaned by personnel wearing suitable personal protective apparel. If a spill of a toxic material occurs outside the hood, an air-supplied full-face respirator may be needed. Immediately contact EHS for assistance.

In addition to the precautions described in this section, researchers should develop written standard operating procedures intended to establish a concise, step-by-step method for carrying out routine laboratory operations with the substance in question and train lab personnel on these procedures.

5. Working with Substances of High Chronic Toxicity

All of the procedures and precautions described in the previous section should be followed when working with substances known to have high chronic toxicity. In addition, when such substances are used in quantities exceeding a few milligrams to a few grams, depending on the hazards posed by the particular substance, the additional precautions described in this section should be followed. Each laboratory worker's plan for project work and for disposing of waste materials must be approved by the laboratory supervisor.

Consultation with the departmental Lab Safety Coordinator is recommended to ensure that the toxic material is effectively contained during the project and that waste materials are disposed of in a safe manner. Substances in this high chronic toxicity category include certain heavy metal compounds (e.g., dimethylmercury and nickel carbonyl) and compounds normally classified as select carcinogens. Examples of compounds normally classified as select carcinogens include the following:

- 2-acetylaminofluorene
  aflatoxin B1.
- benzo[a]pyrene
  bis(chloromethyl) ether.
- 7,12-dimethylbenz[a]anthracene
- dimethylcarbamoyl chloride
- Hexamethylphosphoramide.
- 3-methylcholanthrene.
- 2-nitronaphthalene.
- propane sultone.
- various N-nitrosamides.
- various N-nitrosamines

Record of the amounts of substances of high chronic toxicity being stored and the amounts used, dates of use, and names of users. It is appropriate to keep such records as part of the record of project work in the laboratory workers' research notebook, but it must be understood that the research supervisor is responsible for ensuring that accurate records are maintained.

Any volatile substances having high chronic toxicity must be stored in a ventilated storage area in a secondary tray or container having sufficient capacity to contain the material should the

primary storage container fail. All containers of substances in this category should have labels that identify the contents and include a warning such as:

WARNING! HIGHLY TOXIC OR SUSPECTED CARCINOGEN.

Storage areas for substances in this category must have limited access, and special signs should be posted if a special toxicity hazard exists. .

All projects with and transfers of such substances or mixtures containing such substances must be done in a controlled area (i.e., a laboratory, or a portion of a laboratory, or a facility such as an exhaust hood or a glove box that is designated for the use of highly toxic substances. Its use need not be restricted to the handling of highly toxic substances if all personnel who have access to the controlled area are aware of the nature of the substances being used and the precautions that are necessary). When a glove box is used, the ventilation rate in the box should be at least two volume changes per hour, the pressure should be at least 0.5 inches of water lower than that of the surrounding environment, and the exhaust should be passed through a trap, charcoal or High Efficiency Particulate Air (HEPA) filter as appropriate.

Positive pressure glove boxes are normally used to provide an inert anhydrous atmosphere. If these glove boxes are used with highly toxic compounds, then the box should be thoroughly checked for leaks before use and the exit gases should be passed through a suitable trap or filter. Laboratory vacuum pumps used with substances having high chronic toxicity should be protected by high-efficiency scrubbers or HEPA filters and vented into an exhaust hood. Motor-driven vacuum pumps are recommended because they are easy to decontaminate.

Proper gloves must be worn when transferring or otherwise handling substances or solutions of substances having high chronic toxicity. In some cases, the laboratory worker or the research supervisor may deem it necessary to use other protective apparel, such as an apron of reduced permeability covered by a disposable coat. Additional precautions such as these might be taken, for example, when handling large amounts of certain heavy metals and their derivatives or known potent carcinogens.

Surfaces on which high chronic toxicity substances are handled must be protected from contamination by chemically resistant trays or pans that can be decontaminated after the project or by using dry, absorbent plastic-backed paper.

On leaving a controlled area, laboratory workers must remove any used PPE and thoroughly wash hands, forearms, face, and neck. If disposable apparel or absorbent paper liners have been used, these items must be placed in a closed and impervious container that should then be labeled in some manner such as:

CAUTION: CONTENTS CONTAMINATED WITH SUBSTANCES OF HIGH CHRONIC TOXICITY(for waste disposal purposes, chemical names are required).

Non-disposable protective apparel should be thoroughly washed, and containers of non reusable apparel and protective liners must be disposed of through EHS.

Wastes and residues must be placed in an impervious container and disposed of accordingly. In general, liquid wastes containing such compounds must be placed in a glass or polyethylene bottle half filled with vermiculite.

Normal laboratory work must not be resumed in a space that has been used as a controlled area until it has been adequately decontaminated. Work surfaces must be thoroughly washed

and rinsed. If projects have involved the use of finely divided solid materials, dry sweeping should not be done. In such cases, surfaces must be cleaned by wet mopping or by use of a vacuum cleaner equipped with a HEPA filter. All equipment (e.g., glassware, vacuum pumps, and containers) that is known or suspected to have been in contact with substances of high chronic toxicity should be washed and rinsed before removing from the controlled area.

In the event of continued exposure to a substance of high chronic toxicity (i.e., if a worker regularly uses significant quantities of such a substance at least three times a week), Occupational Health should be consulted to determine whether it is advisable to establish a regular schedule of medical surveillance or biological monitoring.

In addition to the precautions described in this section, lab supervisors must develop written standard operating procedures intended to establish a concise, step-by-step method for carrying out routine laboratory operations with the substance in question. These procedures should be reviewed by a department laboratory safety coordinator.