Tennessee Tech University – Chemistry Department
Chemical Hygiene Plan

revised 12/2/2011

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1. INTRODUCTION

1.1. Goal:

This plan's goal is to protect students, staff, and visitors from potential health hazards associated with the handling, use, and storage of hazardous chemicals in teaching and research laboratories.

1.2. Laboratory Use of Hazardous Chemicals:

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

- Chemical are handled in the course of conducting a teaching laboratory section or doing research;
- Multiple chemical procedures or chemicals are being used;
- Protective laboratory practices and equipment are available and in common use to minimize the potential exposure to hazardous chemicals.

1.3. Hazardous Chemicals:

Hazardous chemicals are those substances for which there is evidence (from at least one scientific study) that health effects may occur in exposed persons. Such chemicals include but are not limited to carcinogens, toxic or highly (acutely) toxic agents, reproductive toxins (mutagens and teratogens), irritants, corrosives, sensitizers, neurotoxins, and agents that damage the lungs, skin, eyes or mucous membranes. It is TTU's policy to minimize all chemical exposure.

2. EMERGENCY RESPONSE INFORMATION

2.1. Any emergency

For any emergency, dial **9 1 1**

2.2. Non-Life Threatening

If circumstances allow calling without endangering human life, notify University Police at 372-3234.

2.3. Chemistry Department Safety Contacts

Chair: Dr. Jeff Boles, 372-3421 (office)

Safety committee members:

Dr. Dan Swartling, 327-3431 (office)

Dr. John Harwood, 372-3473 (office)

Assistant laboratory coordinator: Gene Mullins, 372-3536 (office)

2.4. Fire Plan

2.4.1. Alert:

In the event smoke or fire is detected, immediately use the nearest fire alarm pull box and dial **9 1 1**

Treat all alarms as though they were real. Do not waste precious time wondering if it is a false alarm or not.

2.4.2. Confine:

Close all windows and doors around the fire area to confine smoke and fire.

2.4.3. Evacuate:

When the fire alarm sounds, immediately evacuate the building via the nearest unobstructed exit. Once outside the building, proceed across the street. Do not block sidewalks or fire lanes next to the building.

In the event of an alarm, classroom or laboratory instructors should supervise evacuation of students from their area. Designated floor monitors (section 4.7) will facilitate and confirm complete evacuation of their assigned floor. After confirming all faculty, staff, and students have been evacuated, floor monitors should exit the building. Do not reenter the building until a uniformed emergency responder has given an all-clear.

2.4.4. Special Assistance:

Persons with a disability and who are unable to evacuate the building should seek refuge in the nearest stairway landing. Floor monitors will advise the fire department of the location(s) of persons remaining in the building.

2.4.5.Fire extingishers

Only individuals who have completed fire extinguisher training (section 8) should attempt to use a fire extinguisher and only then on fires that are small and easily put out. Do not allow a fire to block your exit while you are attempting to extinguish a fire.

3. GENERAL REQUIREMENTS

3.1. Definitions and scope

3.1.1.Laboratory:

a facility where the laboratory use of potentially hazardous materials or chemicals occurs.

3.1.2.Personnel:

any students, staff, faculty, or visitors working in a laboratory

3.1.3.OSHA:

Occupational Safety and Health Administration. Refer to 29 CFR 1910.1450 for the OSHA Laboratory Standard.

3.1.4.PEL:

permissible exposure level based upon an 8 hour day as established by OSHA.

3.1.5.TLV:

threshold limit value based upon an 8 hour day as established by the American Conference of Governmental Industrial Hygienists.

3.1.6.MSDS:

Material Safety Data Sheet, a document that provides both workers and emergency personnel with the proper procedures for handling chemical(s) described by that document.

3.1.7.Chemical Hygiene Plan

The Chemistry Dept.'s Chemical Hygiene Plan will cover all chemistry-related laboratories on the Tennessee Tech University campus that present any chemical, radiological, biochemical, or physical hazards.

3.2. Basic rules

3.2.1.Eye Protection

All persons will wear eye protection at all times in a laboratory. There are no exceptions. Failure to wear eye protection will result in expulsion from the laboratory. Goggles or safety glasses with side and top shields will be considered acceptable eye protection.

3.2.2.Eating, drinking, smoking, using smokeless tobacco, applying cosmetics

Do not engage in these and similar actions in laboratories where hazardous substances are handled or stored. Do not store food or beverages in laboratories.

Note: To prevent potential absorption of chemicals by tobacco, do not store tobacco products for personal use in laboratories in which hazardous chemicals are handled or stored.

3.2.3.Personal Apparel

Persons in laboratories shall wear clothing that is compatible with the substances being handled. Confine long hair and loose clothing. Do not wear sandals, flip-flops, or other open-toed shoes that allow any portion of the feet to be uncovered. Students wearing shorts, tank tops, etc. should use a lab apron.

3.2.3.1. Garments contaminated with hazardous materials:

Do not remove garments contaminated with hazardous materials from the building for laundering. Personnel shall remove potentially contaminated personal protective equipment (gloves, lab coats, etc.) prior to leaving the laboratory and handle it appropriately to prevent the potential spread of contamination outside the laboratory or building.

3.2.3.2. Gloves

Personnel will wear gloves of appropriate material when the potential for contact with toxic or corrosive materials exists. In general, do not use natural rubber or cloth gloves for handling hazardous chemicals. Nitrile

gloves are recommended in most cases. Some chemicals can permeate protective gloves in a very short time without visible degradation of glove material. Double or even triple glove for enhanced protection. Inspect gloves before each use to ensure no physical damage (cuts, swelling) is present. If appropriate, wash them before removal. Replace gloves periodically, as needed. If gloves become visibly wet with a chemical and show signs of softening, swelling, stretching, discoloration, etc., discard the gloves immediately. Good practice calls for disposing of gloves after each use.

Take care not to allow gloved hands to inadvertently transfer biological, chemical, and/or radiological contamination to clean surfaces such as door knobs, books, notes, etc.

3.2.4. Portable Media Players

Do not use any type of personal media player, with or without earphones or headphones, while working in a laboratory. Use of such devices could prevent personnel from hearing essential procedural or safety instructions.

3.2.5. Mouth Suction

Never use mouth suction for pipetting or siphoning. Use mechanical pipetting devices, such as pipette bulbs or autopipettes.

3.2.6. Working Alone

Personnel should not work alone when using hazardous chemicals! If using hazardous chemicals and/or working in a laboratory during normal working hours, personnel should ask other faculty or staff to check on them periodically. Undergraduate and graduate students should never work alone if using hazardous chemicals. TTU recommends that staff do not perform potentially hazardous duties by themselves outside normal class hours; however, occasionally doing so may be necessary. Faculty or graduate students working alone in potentially hazardous settings after normal class hours (approximately 8:00 am to 9:00 pm Monday through Friday) should notify campus police (372-3234) or another faculty member

3.3. Ventilation

3.3.1. General

Ventilation provides a source of air for breathing and makeup air for local ventilation devices. It is not intended as primary protection from toxic substances released into the laboratory. The general ventilation system should avoid the intake of contaminated air whenever possible. Vent vacuum pumps, distillation columns, chromatographs, etc., that may discharge toxic amounts of hazardous chemicals, into a local exhaust or hood system whenever possible.

3.3.2. Laboratory Fume Hoods

Provide adequate hood space for persons working with hazardous chemicals. Confirm that the hood exhaust system is working before using a hood by verifying that the face velocity display does not have a low flow alarm. Always work at least six inches back into the hood (six inches beyond the sash line) and keep the sash line between your body and your work. Keep the sash as low as possible to maximize face velocity into the hood and to serve as a primary barrier in case of a splash or spill. . If a fume hood is not in use, the sash should be kept nearly closed to minimize energy use associated with conditioning make-up air. Keep materials and equipment in hoods to a minimum since they can create turbulence and disrupt the laminar flow that is necessary for worker protection. Keep the lower baffle unblocked and fully open. If personnel can detect odors released from materials in the hood area, then the hood may not be functioning properly; notify supervision and post warning signs not to use the hood. . Do not use a hood with a low flow alert for working with hazardous materials. Do not work in an inoperative hood until it has been repaired and verified to be in proper working order.

3.4. Housekeeping

3.4.1. Work Areas

Keep all work areas free of obstructions. Deposit waste in appropriate receptacles. Instruct all lab personnel about the different kinds of waste generated and appropriate methods for disposal. Keep surfaces clean of spilled liquids and solids. Clean areas after use or at the end of each work day.

3.4.2. Access

Never block access to exits, emergency equipment, utility controls and other safety equipment.

3.4.3. Hallways and Stairways

Do not use hallways and stairways as storage areas. Keep all hallways and stairways free of obstructions

3.5. Maintenance

3.5.1. All Equipment

Inspect all equipment regularly for wear and deterioration. Repair or replace all defective equipment prior to further use. Maintain a written log of equipment inspections. Inspect equipment and facilities regularly and insure that necessary maintenance is performed. Develop an adequate lockout system to prevent injury from equipment during maintenance procedures. Coordinate maintenance operations and logs with Facilities.

3.5.2. Fume Hoods

Check fume hoods at least once a year as well as following installation, filter changes, or maintenance activities. The check should include measuring the air velocity by making a traverse with an anemometer or velometer in the face plane of the hood with the sash at the practical work opening width. The average should be at least 100 linear feet per minute and the velocity at each point should not vary by more than 15 percent from the average. The face velocity display on the fume hood monitor can also utilized for monitoring flow. If fume hood monitor caution or alarm lights are on due to low or high flow, alert the assistant laboratory coordinator or designated representative

3.6. Guarding and Shielding

Provide adequate guards for all mechanical equipment, such as vacuum pumps, heating mantles, and centrifuges, to prevent access to electrical connections or moving parts. Use safety shielding for any operation having the potential for an explosion or to minimize exposure to a potential hazard. Ensure that centrifuges are equipped with a cover lock which does not release until spinning has stopped.

3.7. Glassware

Tubing should be fire polished or rounded and lubricated prior to insertion into rubber stoppers. Use only glassware designed for vacuum work if reduced internal pressure is required. Wrap glass vacuum dewars with tape to prevent flying glass if implosion occurs. Use hand protection when picking up broken glass. Glassware with small chips should be fire polished to smooth them out or discarded. Provide each laboratory with a specified container for broken glass/ceramics. Do not pressurize conventional laboratory glassware.

3.8. Flammable Liquids

Restrict flammable liquids in the work area to as small a quantity as possible. Store all flammable liquids in approved safety cans or flammable liquids storage cabinets. Label all containers to denote flammable contents. Equip areas where flammable materials are stored and used with adequate fire extinguishing equipment (Class ABC or BC). Protect glass containers of flammable liquids from breakage as much as possible. Use plastic coated safety bottles whenever possible. Use a safety bucket when transporting non-plastic coated bottles. Do not use an open flame to heat a flammable liquid or to carry out a distillation process under reduced pressure. If an open flame is required for other operations, remove all flammable substances from the immediate area. Remember that fire can travel some distance along a vapor path

from an open flame to the vapor source. When volatile materials are present, use only non-sparking explosion-proof electrical equipment such as explosion-proof refrigerators.

3.9. Explosive Hazards

3.9.1. Organic Peroxides

Organic peroxides, as a class, are low-power explosives that are hazardous because of their extreme sensitivity to shock, sparks, or other forms of accidental ignition. All organic peroxides are highly flammable, and fires involving peroxides should be approached with extreme caution. Use only the smallest amount of peroxides possible. Date all chemicals when received and dispose of old chemicals in accordance with good recommended practices. Clean up all spills immediately by adsorbing onto vermiculite. The sensitivity of most peroxides to shock and heat can be reduced by dilution with inert solvents such as aliphatic hydrocarbons. Avoid solutions of peroxides in volatile solvents since solvent vaporization might lead to increased peroxide concentration. Use ceramic or wooden spatulas, never metal, to handle peroxides. Avoid friction, grinding and all forms of impact near peroxides (especially solid ones). Do not use glass containers that have screw-cap lids or glass stoppers. Polyethylene bottles that have screw-cap lids may be used. To minimize the rate of decomposition, store peroxides at the lowest possible temperature but not below the temperature at which the peroxide freezes or precipitates. Peroxides in solid form are extremely sensitive to shock and heat. Perform all laboratory experiments employing peroxides or peroxide containing solvents behind a shield and with all other recommended precautions.

3.9.2. Picric acid

Picric acid with <10% water presents a potential explosive hazard. Damp picric acid is white; dry picric acid is yellow. Handle yellow picric acid bottles with extreme caution. Check all supplies of picric acid monthly for color and add water as necessary. Limit the amount of acid to minimum required. Maintain a record of the date of receipt of the supply and properly dispose of unused acid before it degrades with time to an unsafe condition. Label all storage areas and containers to indicate the contents and caution against disturbing. Do not store acid in proximity with materials such as oxidizable materials, metals (particularly finely divided) and alkaloids. Store containers in a well secured area equipped with adequate ventilation. Avoid excessive movement or concussion of picric acid containers. Wear appropriate protective equipment when handling the acid to include chemical gloves, laboratory aprons, eye protection, etc. Do not open a container if the acid appears dry. If crystals roll over each other, this may indicate sufficient dryness to be hazardous. Do not attempt dilution of acid unless through familiarization of the safe procedure to be applied has been performed. Spills of picric acid must be properly cleaned up as soon as possible and the residue properly disposed. If a spill occurs in the sink, flush with copious amounts of water. If the spill is on the counter or floor, cover with sand/soda ash mixture. The safest method of disposal is detonation by explosives experts. To clean glassware and equipment contaminated by picric acid, thoroughly wash with a mild bicarbonate solution, followed by a strong soap solution. Regard empty, cleaned containers and equipment as regular waste material. Picric acid is a corrosive material that requires standard acid handling safety precautions.

3.9.3. Perchloric Acid

Perchloric acid solutions in contact with oxidizable or combustible materials or dehydrating and reducing agents may result in fire or explosion. Limit the amount of acid to minimum required. Store perchloric acid bottles in a glass or ceramic dish large enough to contain the entire contents of the bottle. The use of plastic coated safety bottles is strongly recommended. When acid has been removed from a bottle, the outside should be rinsed. All glassware contaminated

with perchloric acid should be thoroughly rinsed. Perform laboratory reactions in a fume hood constructed of non-corrosive material and equipped with a water spray wash-down system capable of decontamination in conjunction with safety shields. Exhaust ducts should take the shortest, non-directional change route to an exterior discharge. Decontaminate the system prior to any repair work. Contact of perchloric acid solutions with strong dehydrating agents such as concentrated sulfuric acid may result in the formation of explosive anhydrous perchloric acid. In wet combustion with perchloric acid, treat the sample first with nitric acid to destroy easily oxidizable substances. Keep perchloric acid away from incompatible organic chemicals. Acid spills should be washed up immediately, using large quantities of water with repeated mopping up and final rinsing of the mopped up material. Neutralize any acid residue before the final disposal. Use only electric hot plates for heating perchloric acid solutions and do not allow the solutions to become anhydrous. Inspect stores of perchloric acid at least monthly and properly dispose of any acid that shows signs of contamination or discoloration. Any procedure or condition that causes perchloric acid to become more concentrated than 72% should be considered potentially hazardous.

3.9.4. Unstable Functional Groups

In general, compounds containing the following functional groups tend to be sensitive to heat and shock:

- acetylide
- azide
- diazo
- haloamine
- nitroso
- ozonide
- peroxide.

Compounds containing nitro groups may be highly reactive, especially if other substances such as halogens are present. Treat perchlorates, chlorates, nitrates, bromates, chlorites, and iodates, whether organic or inorganic, with respect, especially at higher temperatures. Be as familiar as possible with the hazardous properties of the chemicals with which you are working.

3.10. Compressed Gases

Compressed gases can present both mechanical and chemical hazards at the same time. Compressed gases contain a large amount of potential energy, making a compressed gas cylinder a potential torpedo or fragmentation bomb. .The reactivity and/or toxicity of gases can present additional hazards. High concentrations of "harmless" gases such as nitrogen can cause asphyxiation. Handling compressed gases and the associated cylinders, regulators, and tubing requires careful procedures.

3.10.1. Cylinder Contents

Identify gas cylinder contents with decals, stencils, or glued or wired-on tags. Do not accept or use a cylinder that lacks the proper identification. Determine the hazardous properties of a gas (such as flammability, toxicity, chemical activity and corrosive effects) before using the gas. Utilize adequate safety precautions at all times.

3.10.2. Protective Valve Caps

Keep protective valve caps on cylinders at all times, except when containers are connected to dispensing equipment. Do not use cylinders as rollers, supports or for any other purpose than to contain the contents as received. Do not drag, roll, or slide gas cylinders. Use a suitable hand truck for transporting large cylinders. Secure the cylinders to the hand truck with a chain or belt. When a cylinder has been positioned in its place for use, secure it to a wall, a bench or some other firm support, or cylinder stand. Protect cylinders from exposure to damp ground,

sunlight or other high temperatures, precipitation, direct flame, electrical currents, corrosives, physical damage, etc.

3.10.3. Empty and Full Cylinders

Store empty and full cylinders separately. Serious suckback can occur when an empty cylinder is mistakenly attached to a pressurized system. Mark empty cylinders to show they are empty. Never assume that a cylinder labeled "empty" is indeed empty regarding opening of the valve or leaving it unsecured. When returning cylinders, close the valve before shipment and leave some positive pressure in the cylinder

3.10.4. Flammable gas cylinders

Ground cylinders containing flammable gas and bond them to the equipment they serve to control static electricity

3.10.5. Size and total number of cylinders

Keep both the size and number of cylinders present as small as possible. Toxic, flammable and corrosive gases should be used with local exhaust ventilation (such as a fume hood) whenever possible

3.10.6. Traps or suitable check valves

Use a trap or check valve when discharging gas into a liquid to prevent liquid from entering the regulator and cylinder.

3.10.7. Different types of gases stored

Group gases stored at the same location by types of gas and the gases arranged in accordance with the appropriate groups as much as possible. For example, keep oxidizers away from fuel gases. Do not store cylinders near readily ignitable substances or other combustibles. Flammable gases must be protected from sources of ignition such as open flames, arcing electrical equipment, smoking, static electricity, mechanical friction, etc. Post conspicuous signs in areas in which flammable gases are present identifying the substances and appropriate precautions.

3.10.8. Exits, stairways

If possible, do not store cylinders in areas normally used or intended for safe exit from the facility. If possible, cylinders should not be located in areas accessible to the general public when possible and should be protected against tampering.

3.10.9. Matching Equipment

Use cylinders only with appropriate matching equipment for the contents. Do not force the connection or use homemade adapters. Do not use a cylinder without an appropriate pressure regulator. Close cylinder valves when not in use. Do not stop the flow from a cylinder overnight by backing off on the regulator. Even the best quality regulators can malfunction and allow pressure buildup.

3.10.10. Cylinder Filling

Never attempt to refill a cylinder by connecting to one of a higher pressure. Only vendors should refill cylinders.

3.10.11. Valve Access

Place cylinders so that the cylinder valve is accessible at all times. Cylinder valves should be opened slowly. The valve should only be opened to the extent necessary to produce the desired flow, never fully opened against the stop. Never open the valve on an unregulated cylinder.

3.10.12. Cylinder Discharge Lines

If the possibility of flow reversal exists, install an approved check valves to prevent inadvertent contamination of cylinders that are connected to a closed system.

3.10.13. Regular Testing

Inspect and test periodically all equipment used with compressed gases and maintain records. If a leak is suspected, locate the leak using detection techniques appropriate to the gas or equipment involved.

3.11. Cryogenics

Cryogenic liquids present a number of hazards about which personnel should be properly trained. Do not transfer liquefied gases from one container to another for the first time without the direct supervision and instruction of someone experienced in the operation.

3.11.1. Fire/Explosions

Never use liquid nitrogen or liquid air to cool a flammable mixture in the presence of air because oxygen can condense from the air and lead to a potentially explosive condition. Always provide adequate ventilation to prevent the build-up of vapors of flammable gases such as hydrogen, methane, and acetylene or inert gases, such as nitrogen or helium. Keep equipment scrupulously clean to avoid hazardous conditions on contact with cryogenic fluids, especially oxygen.

3.11.2. Pressure

Do not fill cylinders and other pressure vessels used for the storage and handling of liquefied gases to more than 80% of capacity. This action prevents the possibility of thermal expansion and the resulting bursting of the vessel by hydrostatic pressure.

3.11.3. Embrittlement of Structural Materials

Use appropriate impact-resistant containers that have been designed to withstand extremely low temperatures.

3.11.4. Contact With and Destruction of Living Tissue

Even very brief contact with a cryogenic liquid can cause tissue damage resembling that of thermal burns. Prolonged contact may result in blood clots that have potentially serious consequences. In addition, surfaces cooled by cryogenic liquids can cause severe damage to the skin. Recommended apparel when handling cryogenic liquids includes full face protection, impervious apron or coat, cuffless trousers and high-topped shoes. Use gloves that are impervious to the fluid being handled and loose enough to be tossed off easily. Appropriate dry gloves should be used when handling dry ice. Slowly add dry ice "chunks" or cubes to any liquid portion of the cooling bath to avoid foaming over.

3.11.5. Asphyxiation:

As cryogenic liquids warm and become airborne, they may displace oxygen to the point that personnel may experience oxygen deficiency or asphyxiation. Provide good ventilation around cryogenic liquids. For this same reason, personnel should not lower their heads into a dry ice chest since carbon dioxide is heavier than air, and suffocation can result.

3.12. Ionizing Radiation Hazards:

Post appropriate signage at each entrance to an area containing an ionizing radiation source(s). Follow established guidelines regarding the storage, use and management of radioactive material and restrict such activities to approved areas. All users of radioisotopes and sources of ionizing radiation must be approved prior to work. Users imply consent to some exposure above natural background radiation levels. Maintain high cleanliness and housekeeping standards in radiological work areas to prevent accidental intake into the body or transfer outside the work area. Always wear appropriate gloves and wash hands and arms thoroughly on leaving the area. Use double containers (e.g. scintillation vial inside a beaker) for storage. Line work surfaces with adsorbent paper. Provide waste containers labeled “Radioactive Waste.”

3.13. Reactive Chemical Hazards

3.13.1. Water Reactive Chemicals

Laboratory procedures may use chemicals that react violently with water. The danger associated with these chemicals frequently comes from the formation of potentially explosive or flammable gases (e.g. hydrogen). Extreme caution should be exercised when handling water reactive chemicals.

3.13.1.1. Some Water Reactive Chemicals

Alkali Metals
Potassium metal (K)
Sodium (Na)
Lithium (Li)

Alkali Metal Hydrides
Lithium aluminum hydride ($LiAlH_4$)
Sodium borohydride ($NaBH_4$)
Sodium hydride (NaH)
Potassium hydride (KH)
Calcium hydride (CaH_2)

Alkali Metal Amides
Silver amide (Ag_2NH)
Cuprous nitride (Cu_3N)
Cadmium amide ($Cd(NH_2)_2$)
Lead amide (PbNH)
Sodium amide ($NaNH_2$)
Potassium amide (KNH_2)

Metal Alkyls
Alkyllithiums
Aryllithiums
Trialkylaluminums

Halides of Non-Metals
Boron trichloride (BCl_3)
Boron trifluoride (BF_3)
Phosphorus trichloride (PCl_3)
Phosphorus pentachloride (PCl_5)
Silicon tetrachloride ($SiCl_4$)
Sulfur monochloride (S_2Cl_2)

Inorganic Acid Halides
Phosphorus oxychloride ($OPCl_3$)
Sulfur chloride (S_2Cl_2)

Anhydrous Metal Halides
Aluminum chloride anhydrous ($AlCl_3$)
Titanium tetrachloride ($TiCl_4$)
Zirconium tetrachloride ($ZrCl_4$)
Stannic chloride ($SnCl_4$)

Others
Phosphorus pentoxide (P_2O_5)
Calcium carbide (CaC_2)
Organic acid halides and hydrides of low molecular weight

3.13.1.2. Precautions

Protect containers of water reactive chemicals from physical damage and ensure they are tightly sealed during storage. Periodically verify that adequate separation from all sources of water. Post signs at areas containing water reactive chemicals so that fire department personnel and others are aware of the presence of the materials. If electrical equipment is located in areas where larger quantities of the chemicals are stored, it should be of an approved, explosive-proof type. Wear appropriate personal protective equipment including chemical goggles, face shields as warranted, gloves, aprons, etc. Control all possible ignition sources in storage and handling areas. Separate water reactive chemicals from incompatible chemicals such as organic metals, other combustibles, chlorinated hydrocarbons, etc. Store those chemicals, such as lithium and sodium, submerged in Kerosene or other inert oils. Clean up all spills immediately and properly dispose of the residue. Make a Class D fire extinguisher available where water-reactive materials are stored or handled.

3.13.2. Pyrophoric Chemicals

Pyrophoric chemicals react violently on exposure to air leading to spontaneous ignition. Exercise extreme caution when handling pyrophoric chemicals. Use only air-tight, undamaged containers. Follow all recommended storage guidelines from the supplier. Do not handle except in an inert atmosphere. Wear appropriate personal protective equipment to include chemical goggles, face shields as warranted, gloves, aprons, etc. Avoid contact with incompatible materials. Areas containing air reactives should be posted to alert emergency response and other authorized personnel

3.13.2.1. Some Pyrophoric Chemicals

<u>Grignard Reagents</u>
(RMgX)

<u>Metal Hydrides</u>
Sodium hydride (NaH)
Lithium aluminum hydride (LiAlH4)

<u>Metal Alkyls and Aryls</u>
(RLi)
(RNa)
(R3Al)
(R2Zn)

<u>Non-Metal Hydrides</u>
Diborane (B2H6)
Phosphine (PH3)
Arsine (AsH3)
Other boranes

<u>Metal Carbonyls</u>
Nickel tetracarbonyl (Ni(CO)4)
Iron Pentacarbonyl (Fe(CO)5)
Cobalt carbonyl (Co2(CO)8)

<u>Non-Metal Alkyls</u>
(R3B)
(R3P)
(R3As)

Alkali Metals
Sodium (Na)
Potassium (K)

Metal Powders (Particularly when finely divided)
Aluminum (Al)
Cobalt (Co)
Iron (Fe)
Magnesium (Mg)
Palladium (Pd)
Platinum (Pt)
Tin (Sn)
Zinc (Zn)
Zirconium (Zr)
Others
White Phosphorus

4. SAFETY EQUIPMENT AND PROCEDURES

4.1. First Aid

Post first aid policy in lab areas and inform all workers of its content. Keep adequate first aid supplies in each teaching laboratory. Immediately flush chemicals burns with copious amounts of water for at least 15 minutes. All laboratory personnel and students shall have access to emergency equipment, a fire alarm, and telephone for use in an emergency.

4.2. Personal Protective Equipment (PPE)

Wear coveralls, eye protection, gloves, respirators, etc. as appropriate for the degree of hazard present in the laboratory. Responsible faculty members must perform risk assessment for the proper selection of PPE and assume responsibility for the proper selection and maintenance of PPE. Inform all personnel of PPE requirements and train them in the proper use of PPE. . Regularly check all PPE for integrity and maintain it in clean, functional order. Make PPE readily available for use at all times with storage areas designated by signs or labels. Use a respirator where necessary. All personnel and students must wear eye protection (safety goggles with side shields or equivalent) at all times in laboratories where hazardous chemicals are used or stored or where processes present a significant potential for eye injury. Contact lens wear is not encouraged but may be determined by responsible faculty members.

4.3. Emergency Safety Equipment

Provide emergency safety equipment to all laboratory personnel and ensure familiarity with the safety facilities and procedures in the lab. All lab workers are expected to know the locations of fire alarm pulls, fire blankets, safety showers, eye washes, spill clean-up kits and emergency exits. Provide approved eyewash stations in each laboratory that utilizes hazardous chemicals or materials/equipment that might cause a significant eye injury. Provide safety showers in each laboratory that utilizes hazardous chemicals or materials/equipment which might require drenching to remove the hazard from an individual except where the overall hazard of the laboratory would be increased by the presence of a shower unit coupled with existing instrumentation (i.e. electrical shock hazard due to the presence of instrumentation, etc.). In this case, a shower in an adjacent area may be used.

4.4. Fire Extinguisher Access and Maintenance

Provide readily accessible fire extinguishers that are charged and regularly inspected. IF DISCHARGED, contact the Director-Environmental Health & Safety to get the extinguisher serviced and returned

4.5. Laboratory safety equipment

Appropriate university personnel will inspect lab safety equipment and furnishings such as showers, eyewashes, hoods, glove boxes, vacuum pumps, electrical outlets and cords, etc. at least annually.

4.6. Spill Control and Procedures

If a potentially hazardous spill occurs, immediately notify the Director-Campus Safety and Environmental Services for containment procedures, removal of hazardous material, or further recommended actions Recommended chemical spill kits should contain: sodium bicarbonate or commercial acid neutralizer; vermiculite; citric acid or commercial caustics neutralizer, rubber gloves, pH papers, safety glasses/goggles, rubber boots and several "area closed" signs. Containment pillows and/or socks may be substituted for use in spill containment. Personnel involved in cleaning a chemical spill must utilize appropriate protective equipment and supplies.

4.7. Evacuation

Possible reasons for evacuation include but are not limited to fire, major chemical spills, severe weather, and bomb threats.

Call university police at **9 1 1** or x3234. University police will broadcast an evacuation announcement on the building public address system.

The following personnel in Foster Hall are responsible for evacuation coordination on their respective floors

4^{th} floor - Lydia Kendall (x3476) or Janet Whiteaker (x3456)
3^{rd} floor - Gene Mullins (x3536) or David Crouse (x3515)
2^{nd} floor - Jeff Boles (x3421) or John Harwood (x3473)
1^{st} floor - Dale Ensor (x3493) or Dan Swartling (x3431)

Proceed to the nearest clear exit to evacuate building. Use stairwells, not the elevator, to move between floors. Move away from the building after exiting. Do not reenter the building until told to do so by responsible personnel.

4.8. Signs and Labeling

Designate all safety equipment, hazardous chemical storage and use areas, labs with unusual hazards (e.g. high magnetic fields), etc. with appropriate signage.

5. PRECAUTIONS FOR WORKING WITH HAZARDOUS MATERIALS

5.1. Precautions and Approvals

Handle carcinogens, genotoxins, reproductive toxins and chemicals with a high degree of acute toxicity using special precautions to minimize exposure risks. Use and store no more of these chemicals than is absolutely necessary. Work with these chemicals only in a functional fume hood, glove box, or other suitable containment system. Outside the work area, post warning signs listing the chemical(s) and permitting authorized personnel only. Pregnant women must consult with the Director-Campus Safety and Environmental Services prior to working with mutagens or teratogens. All personnel will use HEPA filtration to protect fume hood exhausts, vacuum lines, etc.; decontaminate the area after use; and dispose of waste per instructions from the Director-Campus Safety and Environmental Services. Approved emergency response plans will be in place prior to work.

5.2. Chemicals of High Chronic and Acute Toxicity

Chemicals of high chronic toxicity will show delayed, usually irreversible effects after repeated exposure while chemicals of high acute toxicity will show quick, sometimes reversible effects after a single short exposure. Use these chemicals in a controlled access laboratory. Decontaminate any equipment before removing it from the laboratory or dispose of it as hazardous waste. Remove and dispose of protective clothing when leaving the laboratory. Post signs designating the restricted access area.

5.3. Carcinogens

Follow all precautions outlined in section 5.1 when working with known or suspected carcinogens. Label all waste as “Cancer Suspect Agent.”

5.4. Teratogens and Mutagens

Teratogens and mutagens can affect a developing embryo or fetus or adversely alter the DNA of an exposed person. Common chemicals suspected of being mutagens and teratogens include:

Benzene	Vinyl Chloride	Hydrogen sulfide
Toluene	Formaldehyde	Carbon disulfide
Xylene	Dimethylformamide	Carbon monoxide
Aniline	Dimethyl sulfoxide	Nitrates
Nitrobenzene	N,N-Dimethylacetamide	Nitrites
Phenol	PCB	Lead
Mercury	Nitrous Oxide	Formamide

5.5. Allergens and Embryotoxins

When handling allergens and embryotoxins, wear appropriate PPE, work in a functional fume hood, and wash exposed skin areas thoroughly afterwards

5.6. Acute Respiratory Hazards

Use chemicals that are acute respiratory hazards only with adequate ventilation, never in a confined space. Common examples of these chemicals include:

Acetyl Chloride	Fluorine	Diborane
Ammonium hydroxide	Hydriodic acid	Methyl fluorosulfonate
Anhydrous ammonia	Hydrobromic acid	Dimethyl oxychloride
Arsine	Hydrochloric acid	Phosgene
Bromine	Hydrofluoric acid	Sulfur dioxide
Carbon monoxide	Hydrogen selenide	Stibine
Chlorine	Hydrogen sulfide	Thionyl Chloride
Chloroform	Hydrogen telluride	

5.7. Corrosive Chemicals

Corrosive chemicals include strong acids, strong bases, dehydrating agents, and oxidizing agents. They cause damage to skin, respiratory tissue, and eyes. Flush exposed skin with water for at least 15 minutes, and then seek immediate medical attention. Use nitrile gloves, rubber aprons, and face shields/goggles when handling bulk quantities of corrosive chemicals. Have spill control materials readily available. Store corrosives in as close to floor level as possible, preferably in corrosion-resistant trays. Use safety buckets for transporting corrosive chemicals.

6. CHEMICAL MANAGEMENT

6.1. Chemical Storage

Store chemicals in alphabetical order only if they are in compatible chemical categories. Take precautions not to store oxidizing agents and other reactive chemicals close to interactive agents. Minimize chemical storage areas. Do not use bench tops and in hoods as chemical storage areas. Do not store glassware or other equipment in hoods. Ventilated cabinets and designated refrigerators are used for chemical storage only. Do not store food in chemical storage refrigerators. Chemicals, especially liquids, should never be stored on the floor. Large bottles (2.5L or larger) should not be stored above the bench top.

6.2. Chemical Inventory

Update the chemical inventory at the end of each semester for teaching lab prep rooms and common storage areas. Include the name of the chemical and the approximate total amount of chemical in each storage container.

6.3. Transport of Chemicals

Use appropriate safety equipment (such as lab carts, safety buckets, and gas carts for gas cylinders) while moving chemicals within and between laboratories and storage

areas. Use the elevator to move large containers, gas cylinders, and dewars between floors.

6.4. Labels

Each and every container must have an accurate label. Hand-written labels must specify the name of the chemical(s), CAS number (if known), the person(s) responsible, and the date the chemical was generated. Containers that do not have appropriate labels will be considered waste, segregated from active storage areas, and shall be disposed at the earliest opportunity

6.5. Material Safety Data Sheets

The chemistry stockroom shall maintain a file of MSDS's for all chemicals received into the building. Keep MSDS's for reagents, solvents, and products encountered in teaching labs in each respective teaching lab. MSDS's must be accessible at all times.

6.6. Interdepartmental Chemical Transfers:

The Chemistry Dept. recognizes that other departments may require small amounts of chemicals from the department. Faculty members (or their designated representatives) from other departments must present an MSDS for the desired chemical prior to receiving that chemical This ensures that the faculty members (or their designated representatives) are aware of any hazards associated with transport, use, and storage of that chemical. An inter-departmental transfer (IDT) form must be filled out for quantities larger than 250 g or 250 mL of common chemicals or any amount of hazardous chemical.

7. MEDICAL SURVEILLANCE

7.1. Criteria for Reasonable Suspicion of Over-Exposure

Personnel who encounter a spill of hazardous chemicals, experience direct skin or eye contact with hazardous chemicals, or exhibit symptoms of exposure may have been over-exposed.

7.2. Signs and Symptoms

Personnel who exhibit signs and symptoms of over-exposure should report to Health Services. Notify the Director-Campus Safety and Environmental Services.

7.3. Medical Examinations and Consultations

7.3.1. University Employees

The University will provide all employees who work with hazardous chemicals an opportunity to receive medical attention as warranted and in compliance with Section (g) "Medical Consultation and Medical Examinations" of Tennessee Occupational Safety and Health Administration (TOSHA) "The Occupational Exposure to Hazardous Chemicals in the Laboratory Standard" (29 CFR 1910.1450). Employees are encouraged to review and become familiar with the specifications

7.3.2. Non-University Employees and Students

Non-University employees and students shall bear the expense for medical surveillance and treatment in the event of an accidental exposure to a hazardous chemical. These individuals may contact the Director-Campus Safety and Environmental Services to request access to filing appropriate claims for compensation pursuant to the guidelines set forth by the Tennessee Claims Commission

7.4. Medical Records

The University will maintain medical records as per state and federal regulations.

8. TRAINING

8.1. Faculty/Staff

All faculty and staff members shall complete the on-line training in fire extinguishers, lab safety, RCRA, and right-to-know available from the Director-Campus Safety and Environmental Services and repeat the training annually. All faculty and staff members must make a minimum score of 80 on the quiz at the end of each training

section. The assistant laboratory coordinator or designated staff member shall keep quiz scores on file.

8.2. Teaching assistants and researchers

All teaching assistants and researchers (graduate and undergraduate) must complete the on-line training in fire extinguishers, lab safety, RCRA, and right-to-know available from the Director-Campus Safety and Environmental Services. All TA's must make a minimum score of 80 on the quiz at the end of each training section. The assistant laboratory coordinator or designated staff member shall keep quiz scores on file. All teaching assistants must complete the training before the first lab section they teach and annually after that.

8.3. Students

All students will be given basic safety instructions at the initial meeting of their respective lab sections. These instructions should be pertinent to each respective lab.

9. WASTE DISPOSAL

Unwanted chemicals or waste chemicals must have a completed Waste Chemical Disposal label or the original commercial label on each container.

Containers of unwanted chemicals may be taken to the waste storage area in the main chemical storeroom and stored in accordance with section 6.1 of this document.

A waste is hazardous if it exhibits any of the characteristics (ignitability, corrosivity, reactivity,or toxicity) of a hazardous waste, is listed by regulation as a hazardous waste, is a mixture containing a hazardous waste, or is generated by the treatment, storage, or disposal of a hazardous waste.

Unless chemicals are known to be completely non-hazardous or are excluded from regulation, do not pour chemicals down the drain or handle in any way except in accordance with safe and established protocols.

Keep waste containers closed except when adding waste. Open waste containers are considered a violation of EPA regulations. Letting water evaporate from aqueous wastes to reduce their volume is not permissible. Do not mix chemically incompatible wastes (i.e. do not mix aqueous with organic waste, oxidizers with reducing agents, etc.).

For hazardous waste codes, hazardous waste labels, training links, and disposal forms, refer to http://www.tntech.edu/ehs/wastedisposal/

10. REFERENCES

Oak Ridge National Laboratory, “Chemical Hygiene Plan, Rev. 4” 2005
University of Tennessee-Knoxville, “The Laboratory Chemical Hygiene Plan” 2005
University of Tennessee-Chattanooga, “Chemical Hygiene Plan” 2005
University of Alabama, “Chemical Hygiene Plan and Laboratory Guide” 2000