

Laboratory
Chemical Hygiene Program

NOTICE TO USERS

This Laboratory Chemical Hygiene Program, initially approved by The University of Memphis Chemical Hygiene Committee on April 10, 1996, is intended to assure compliance with occupational safety and health standards covering employees engaged in the laboratory use of hazardous chemicals as defined in 29 CFR 1910.1450; it represents official University policy on the possession, storage, and use of hazardous chemicals in laboratories.

This program was last updated on April 9, 2009. Copies of this program and regulations cited herein are available for viewing during regular business hours in the office of Environmental Health and Safety (EH&S). Electronic copies may be downloaded from the EH&S web site.

This program is subject to review and modification on an annual basis. Laboratory staff are encouraged to submit revision requests and suggestions to the Chemical Hygiene Committee for consideration.

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The University of Memphis Laboratory Chemical Hygiene Plan

This document, known as the Chemical Hygiene Plan or the Plan, is designed to minimize exposures to hazardous chemicals in laboratories, thereby protecting the health and safety of laboratory employees. This Chemical Hygiene Plan is examined annually for effectiveness and modified as appropriate. Implementing the Plan should be a continuing effort on the part of all.

Copies of this Plan are available for employee review in the Office of Environmental Health and Safety (EH&S). Electronic copies can be downloaded from the EH&S web site at <http://ehs.memphis.edu>. Employees are expected to implement the prudent practices and precautions contained herein as a means of promoting a safe and healthful environment for the University community.

General Requirements

Scope and Applicability

The Chemical Hygiene Plan applies to all areas engaged in the laboratory use of hazardous chemicals. *Laboratory use* implies handling or use of hazardous chemicals where:

- Chemical manipulations are carried out on a “laboratory scale” (i.e., containers used for reactions, transfers, and other handling are designed to be easily and safely manipulated by one person)
- Multiple chemical procedures or chemicals are used
- Procedures are not part of a production process, nor in any way simulate a production process
- Protective laboratory practices and equipment are available and in common use

Hazardous chemical usage that does not meet the definition of laboratory use is not covered by this document, even if such use occurs in a laboratory. Laboratory use of hazardous chemicals that provides no potential for employee exposure, such as dip-and-read test kits, are likewise excluded from these requirements. Excluded uses are covered under the University Occupational Safety and Health Program (UM1293).

Responsibilities

The President of The University of Memphis has ultimate responsibility for chemical hygiene within the University and, with other administrators, chairs, and directors, provides continuing support for the University's Laboratory Chemical Hygiene Program.

Chemical Hygiene Committee

The Chemical Hygiene Committee governs the development and implementation of the Chemical Hygiene Program. The members of this committee are appointed by the President and are selected from the faculty and staff on the basis of their knowledge and experience with chemical use in laboratories.

Environmental Health & Safety

Environmental Health and Safety (EH&S) executes the day-to-day administrative responsibilities of the Chemical Hygiene Plan, including but not limited to audits, training, and consultation.

Chemical Hygiene Officer

The Chemical Hygiene Officer is the chief administrative officer for the Laboratory Chemical Hygiene Program. The Chemical Hygiene Officer's duties include the following:

- Working with administration, Chemical Hygiene Committee, and other employees to develop and implement appropriate chemical hygiene policies and practices
- Monitoring procurement, use, and disposal of chemicals used in laboratories
- Seeing that appropriate audits are maintained
- Helping faculty develop precautions and adequate facilities
- Knowing the current legal requirements concerning regulated substances
- Seeking ways to improve the Laboratory Chemical Hygiene Program

Chairs and Directors

Department chairs or directors are responsible for general oversight of the chemical safety efforts within their respective areas, including:

- Implementing an information and training program for all individuals engaged in laboratory use of hazardous chemicals
- Identifying hazardous laboratory operations requiring prior approval
- Reviewing requests for prior approval and granting Chemical Hygiene Permits as appropriate
- Ensuring implementation of and full compliance with procedures for decommissioning areas where hazardous chemicals have been used or stored
- Maintaining records, including but not limited to training records, hazard assessments, inventories of particularly hazardous substances, and Material Safety Data Sheets (MSDSs)
- Ensuring testing of safety equipment (e.g., emergency eye washes) according to recommended schedules
- Forwarding employee medical records/physicians' opinions to the Benefits Section of Human Resources
- Centralizing ordering of hazardous chemicals within the department

Faculty and Supervisors

These individuals have overall direct responsibility for safety in the laboratory, including:

- Ensuring that laboratory workers know and follow the chemical hygiene rules
- Ensuring that personal protective equipment is available, adequate and used
- Ensuring that appropriate training has been provided
- Developing and maintaining appropriate written Standard Operating Procedure (SOPs) for the safe use of hazardous chemicals within their area(s)
- Providing regular chemical safety and housekeeping inspections, including inspection of emergency equipment
- Ensuring that facilities and equipment for use of any chemical are adequate and functioning properly
- Ensuring that up-to-date inventories of hazardous materials are maintained and copies forwarded to EH&S at least annually and upon significant changes in quantities or types of hazards
- Reducing amounts of hazardous chemicals in accordance with the Hazardous Waste Reduction Plan (UM1296)
- Communicating with the Chemical Hygiene Officer when new Particularly Hazardous Chemicals are introduced into their work areas
- Ensuring prior approval of hazardous laboratory operations (Chemical Hygiene Permit)
- Knowing the current legal requirements concerning regulated chemicals

- Assessing risks associated with hazardous chemicals present in their laboratories and determining appropriate requirements for protective apparel and equipment
- Initiating and following up on action to eliminate hazards and/or unsafe conditions within their laboratory areas
- Reporting accidents to Employee Safety and Health
- Initiating and complying with laboratory decommissioning procedures prior to vacating any laboratory space
- Reporting release of hazardous materials to the soil, sewers, or atmosphere to EH&S

Laboratory Personnel

These individuals shall be responsible for the following:

- Planning and conducting operations in accordance with this Chemical Hygiene Plan
- Developing good personal chemical hygiene habits
- Complying with all rules, regulations, policies, and instructions pursuant to occupational safety and health standards and environmental standards
- Wearing prescribed personal protective equipment (PPE)
- Cleaning, washing, storing, and disposing of PPE appropriately
- Reporting unsafe conditions and practices to their supervisor
- Stopping work activities if an imminent danger exists, any change in the scope of work occurs that could significantly impact worker health and safety and/or the environment, significant new hazards are identified, existing hazards cannot be controlled, and/or work conditions change so as to potentially impact worker health and safety or the environment

Information and Training

It is the responsibility of each department chair to establish an information and training program to assure that all laboratory employees are adequately informed of the hazards associated with the chemicals in the lab and what to do in case of an accident. EH&S serves as a ready resource to assist with this task; faculty, staff and students are encouraged take advantage of services provided by EH&S.

Training

Each employee shall receive training at the time of initial assignment to the laboratory, prior to assignments involving new chemicals or new exposure situations, and at regular intervals as determined by the laboratory supervisor or Chemical Hygiene Committee. Departmental training should be a continuing activity rather than an annual event. Formal training on general laboratory safety is offered at least annually by the Chemical Hygiene Officer or designee.

Training shall include methods of detecting the presence or release of hazardous chemicals; physical and health hazards of chemicals in the lab; appropriate protective measures; details, location, and availability of this Chemical Hygiene Plan; contents of the OSHA Laboratory Standard (29 CFR 1910.1450); permissible exposure limits; signs and symptoms associated with exposure to the chemicals present in the laboratory; and location and availability of reference material on chemical hygiene.

The "Chemical Hygiene Training Record" found in the on-line appendices can be used to guide and document training activities; employee training records shall include documentation that they have been informed of the hazards associated with the chemicals in the work area. The University "Hazardous Chemicals Right-to-Know Notebook" (available from Environmental Health and Safety) contains valuable chemical safety information and can serve as a useful training aid; keep the notebook in a convenient, readily accessible location.

Labels and Material Safety Data Sheets

Container labels and Material Safety Data Sheets hold a wealth of information on chemical compounds. The hazards presented by a material can be learned from a quick glance at a container label. Material Safety Data Sheets (MSDSs) contain detailed information on a chemical's physical and health hazards, as well as handling precautions, recommendations for protective equipment, and first aid guidance.

Environmental Health & Safety (EH&S) maintains a master file of all MSDSs. Departments shall ensure that chemical vendors provide an original copy of the MSDS to EH&S; EH&S shall then return a copy of the MSDS to the ordering department which shall maintain these copies so as to be readily accessible to their employees.

Labels on incoming containers of hazardous chemicals shall not be removed or defaced. All containers, including stock solutions and squirt bottles, shall have identity labels. These labels shall be written in plain English and shall identify the enclosed substance and associated hazard(s). Containers that have been emptied for reuse (such as waste collection) shall be re-labeled appropriately. Labels shall be intact and legible.

Substances Developed in the Lab

If a chemical is produced exclusively for the laboratory's use, it must be determined if it is a hazardous chemical. If it is deemed to be a hazardous chemical, appropriate training must be provided. Chemicals that are byproducts of unknown composition shall be assumed to be hazardous. Chemicals produced for a user outside the laboratory require implementation of the OSHA Hazard Communication Standard (29CFR1910.1200), including generation of Material Safety Data Sheets and container labeling.

Signage

Signs shall be posted indicating locations of safety showers, eye-wash stations and areas where food and beverage consumption and storage are permitted. Refrigerators shall have signage affixed indicating, where appropriate, that flammable liquids are not permitted and that food for human consumption is not permitted. These signs can be obtained from EH&S.

Fume hoods not specifically designed for perchloric acid shall have a label affixed stating "Not for Perchloric Acid." Warning signs shall be posted at areas or near equipment where special or unusual hazards exist, such as in Designated Areas or where required by regulations. Doors to laboratories and storage areas shall be appropriately marked with hazard warnings. Emergency phone numbers should be posted next to the telephone.

Reference Material

Literature, reference material, and consulting advice about chemical hygiene is readily available to lab workers; they should be encouraged to use these resources. The University "Hazardous Chemical Right-to-Know Notebook" is among these resources. Environmental Health and Safety maintains a library of laboratory safety materials including training videos, Material Safety Data Sheets, information on toxicological and physical hazards of chemical compounds, as well as relevant regulatory information.

Medical Consultations and Exams

An opportunity to receive medical attention is available to all employees who work with hazardous chemicals in the laboratory. Medical consultations and examinations shall be

provided to qualifying employees without cost, without loss of pay, and at a reasonable time and place. Employees shall be offered the opportunity for medical attention under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory
- Whenever an event takes place in the laboratory such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure
- Where exposure monitoring reveals an exposure level above the action level for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements

Medical consultations and examinations shall be administered by, or under the direct supervision of, a licensed physician. Departments with employees utilizing medical consultations and/or evaluations shall provide the following information to the physician:

- The identity of the hazardous chemical(s) to which the employee may have been exposed;
- A description of the conditions under which the exposure occurred including, quantitative exposure data, if available; and
- A description of the signs and symptoms of exposure that the employee is experiencing, if any.

The physician shall provide the University with a written opinion resulting from medical exams/consultations. It is the responsibility of the affected employee's department to ensure that the written opinion is forwarded to the Benefits Section of Human Resources. While not revealing specific findings of diagnoses unrelated to occupational exposure, the written opinion shall include the following:

- Any recommendation for further medical follow-up;
- The results of the medical examination and any associated tests;
- Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and
- A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

Employees injured on the job should utilize one of the medical providers authorized by the State of Tennessee under its Workers' Compensation program. Employees should contact the Benefits Section of Human Resources for additional information. Laboratory supervisors are encouraged to post information on the location of nearest approved medical services providers for quick reference. Student Health Services does not treat employees injured on the job.

Recordkeeping

Principal Investigators, project directors, and/or laboratory supervisors shall maintain an inventory of all hazardous materials present in their area(s). The hazardous materials inventory shall be updated at least annually and upon significant changes in quantities or types of hazards. Copies of the hazardous materials inventory shall be forwarded to EH&S which will maintain these records for at least thirty (30) years. Similarly, individual departments shall maintain up-to-date inventory and usage records for particularly hazardous substances. Records of employee training shall be maintained for thirty (30) years by the department providing training.

Employee medical records are confidential and shall be forwarded to the Department of Human Resources for proper filing and retention for the duration of employment plus thirty (30) years. Accident records are maintained by the Employee Safety and Health Office.

Controlling Chemical Exposures

Exposure to hazardous chemicals can occur through inhalation, skin contact, ingestion, and injection. In the workplace, inhalation and skin absorption are the primary routes of exposure. Ingestion can occur accidentally either through eating or drinking in the lab, contamination of skin or clothing, or swallowing inhaled particulates that have been deposited in the nose or throat. Injection-like exposures can occur as a result of needle sticks, pipette tip punctures, cuts or abrasions.

Engineering controls, safe work practices, and personal protective equipment are used to protect personnel from these routes of exposure; when properly selected and used, these are effective tools for minimizing exposure to hazardous chemicals in the laboratory.

The Laboratory Facility

The type of work conducted in a laboratory and the scale of that work must be appropriate to the facility. While it is incumbent upon the laboratory supervisor to determine the specific requirements of an individual laboratory facility, at a minimum each laboratory should have appropriate general ventilation that avoids recirculation or re-entrainment of contaminated air; handwashing facilities; and ready access to safety equipment such as drench-type safety shower, plumbed eye wash station, fire extinguisher, fire alarm, and telephone.

Safety showers and/or eye washes shall be available in the work area to personnel when the eyes or body may be exposed to injurious corrosive materials. Access to showers and eye washes shall be unimpeded by closed doors, stored materials, etc. EH&S tests showers and eye washes annually; however, it is the responsibility of the possessing department to test/flush eye washes on a weekly basis and document such tests.

Engineering Controls

Engineering controls isolate or remove the hazard at the source. Engineering controls are the preferred method of hazard control because they prevent the hazard from entering the work environment. Common engineering controls found in laboratories include chemical fume hoods, biological safety cabinets, glove boxes, and ventilated storage cabinets.

General Laboratory Ventilation

General lab ventilation (HVAC) provides a source of conditioned air for laboratory personnel and for input to local ventilation devices. General ventilation should ensure that lab air is continually replaced. Air should flow into the lab from non-lab areas (e.g., hallways) and exit directly out the exterior of the building; laboratory air should never be recirculated. While general laboratory ventilation can prevent accumulation of airborne contaminants, it cannot be relied upon for protection from hazardous substances released into the lab.

Fume Hoods and Other Local Exhaust Devices

Fume hoods and other local exhaust devices prevent exposure to airborne chemicals by capturing contaminants at the point of generation and exhausting them to the outside. Apparatus such as vacuum pumps that might discharge hazardous substances into the work space should be vented into a local exhaust device. Ductless hoods are unsuitable for use with hazardous chemicals; they shall only be used for controlling nuisance vapors or dusts.

The use of fume hoods shall be limited to units that meet current safety acceptance criteria described in the U of M *Laboratory Ventilation Management Program*, a copy of which is available for inspection in EH&S. Each hood shall have a properly functioning air flow monitoring device to allow quick confirmation of adequate hood performance, defined as 90-110 linear feet per minute air flow. Routine fume hood test results are recorded on inspection stickers affixed to the face of each fume hood. Fume hoods with warning labels, with inadequate air flow indicated on the monitor, or that have not been inspected within the past twelve months shall not be used for work with hazardous chemicals. Never attempt to use a hood that is off-line for repairs as this could expose maintenance personnel and yourself to hazardous chemicals.

Professional oversight of ventilation alterations is essential to ensure worker protection from airborne contaminants; therefore, ventilation system alterations are permissible only with prior approval from Physical Plant in consultation with EH&S.

Work Practices

Work practice controls alter the manner in which a task is performed so that risks are reduced. Some fundamental, easily implemented work practice controls include:

- Eliminating hazardous chemicals from the process
- Substituting less hazardous chemicals
- Reducing quantities of hazardous chemicals used and stored
- Developing and using Standard Operating Procedures (SOPs)
- Inspecting and maintaining safety equipment
- Exercising good housekeeping
- Conducting regular lab inspections

Each employee, through training, supervision, encouragement, and experience, shall develop and implement safe working habits in accordance with this document and the University Occupational Safety and Health Program (UM1293). Safe work habits must also extend to those chemicals without known hazards, ensuring that exposure will be as low as reasonably achievable and that personnel do not under-estimate risk. **Assume that any mixture will be more hazardous than its most hazardous component and that all substances with unknown hazards are hazardous.**

Personal Responsibility

Individuals are ultimately responsible for their own actions. Personal safety awareness is essential in settings where the potential for personal harm is present. This awareness includes a thorough knowledge of procedures, surroundings, and inherent risks. Prior to initiating a procedure, its potential impact on personnel in the surrounding area should be thoroughly considered.

Personal Protective Equipment

Personal protective equipment (PPE) is the last line of defense against hazardous chemical exposures. Before PPE use may be considered, personnel must first minimize exposure through the use of engineering controls and safe work practices. Where substance specific OSHA Standards prohibit skin and eye contact, such contact is prohibited in the laboratory as well. Personnel using any form of PPE must be trained in accordance with OSHA standards. It is the obligation of affected departments to determine the need for PPE through application of a workplace hazard assessment; a copy of the assessment shall be held on file for inspection. Where a hazard assessment indicates the need for PPE, departments shall provide

PPE at no cost to the employee. PPE shall be supplied in sizes and styles to provide effective fit of each employee. Departments should be prepared to provide, at a minimum, lab coats, protective eyewear, and gloves. The PPE Assessment Tool found in the on-line appendices can be used to guide and document the hazard assessment. EH&S can assist departments in conducting hazard assessments and in selecting appropriate PPE.

When PPE is used for work with hazardous chemicals, it shall be removed and left in the laboratory before leaving for non-laboratory areas (e.g., cafeteria, library, administrative offices). Gloves are not to be used for touching "clean" surfaces (keyboards, telephones, etc.). Contaminated clothing may be properly laundered in-house or be given to a suitable outside contractor. Contaminated clothing, including lab coats and other protective clothing, shall not be taken home by personnel. Leather goods soaked with hazardous materials should be properly disposed as a matter of routine since decontamination of such porous materials is nearly impossible.

Protective Eyewear

All eye protection shall comply with the most current version of the American National Standards Institute (ANSI) Standard Z87.1. Splash goggles are required when working with large volumes of hazardous chemicals or where the possibility of a chemical splash is significant; more stylish eyewear with side shields may be worn in low risk areas at the discretion of the laboratory supervisor. Where the possibility of flying particles exists, such as when working with glassware under reduced or elevated pressure, appropriate goggles should be worn. Since impact goggles are vented, they do not offer protection against chemical splashes or sprays. A face shield may be necessary under certain conditions, such as when visualizing or photographing with UV light. A face shield in combination with splash goggles may be necessary when dispensing large quantities of hazardous chemicals or in situations where splattering may occur (e.g., working with reactive chemicals).

Skin Protection

Skin protection includes use of a lab coat, chemical resistant gloves, and rubber aprons or other protective garments as appropriate. These garments are not to leave the work area. At a minimum, laboratory employees shall be provided with a lab coat and gloves appropriate for the chemicals and procedures in use. Gloves should be selected according to their resistance to the chemicals in use and anticipated exposure intensity and duration. Disposable latex gloves offer a minimum level of chemical resistance; however, they are unsuitable in many exposure situations. Disposable nitrile gloves are often a better choice than latex but are still not appropriate for all exposure scenarios. Laboratory workers should consult the MSDS and glove manufacturers' technical literature when selecting a glove appropriate for the chemical and process in use.

Respiratory Protection

With judicious use of chemical fume hoods and other controls, the vast majority of laboratory workers will never need to use a respirator. Should those primary methods fail to control exposures below permissible exposure limits (PEL) or action level, appropriate respiratory protection shall be used. Employees required to use a respirator must receive a medical clearance, proper qualitative or quantitative fit testing, and training as specified in the OSHA Respiratory Protection Standard (29 CFR 1910.134). Employees whose sole use of respiratory protection involves voluntary use of disposable dust masks are exempt from portions of the Standard. Contact EH&S for further guidance on laboratory use of respirators or dust masks.

Exposure Monitoring

Regular air monitoring of is not usually justified or practical in labs but may be appropriate when testing or redesigning hoods or other ventilation devices, or when highly toxic chemicals, carcinogens, or chemicals with reproductive hazards are stored or used regularly (3 times a week). Exposure monitoring may also be conducted if there is reason to believe that exposure levels for a substance routinely exceed the action level or permissible exposure limits. Laboratory personnel shall be informed of the results of air sampling by the responsible department within 15 days of receiving such results. Contact EH&S for guidance where air sampling or other industrial hygiene services may be needed.

Standard Operating Procedures

Written standard operating procedures (SOPs) shall be developed relevant to health and safety considerations when using hazardous chemicals in the laboratory. Fundamental laboratory safety practices and procedures are outlined below. Generic SOPs can be found in the on-line appendices. Individual departments, Principal Investigators, and laboratory supervisors must develop their laboratory-specific and/or procedure-specific SOPs for chemicals and/or exposure situations not adequately covered by these prudent practices.

General Laboratory Safety

Since few lab chemicals are without hazard, all chemical exposures shall be minimized. Before beginning any new operation, seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment. Follow these general precautions for handling lab chemicals.

- Splash goggles shall be worn where the possibility of a chemical splash or spray exists. More stylish safety eyewear with side shields may be worn in low risk areas at the discretion of the lab supervisor. All protective eyewear must comply with the most recent American National Standards Institute (ANSI) Standard Z8.7.
- Laboratory coats of appropriate type shall be worn. Lab coats shall be removed upon significant contamination and before leaving the laboratory.
- Gloves designed to resist the chemical being handled shall be worn when appropriate. Inspect gloves before use, wash reusable gloves before removal, and replace periodically. Gloves shall be removed prior to leaving a laboratory area.
- Wash hands thoroughly after handling chemicals, after removing gloves, before leaving the laboratory, and before eating, drinking, using the restroom, etc.
- Long hair and loose clothing shall be confined close to the body. Dangling jewelry, sandals, perforated shoes, cloth shoes, and shorts are prohibited in the laboratory.
- Practical jokes, horseplay, and other behavior that may startle, confuse, or distract other workers are prohibited.
- Pipetting and siphoning by mouth are prohibited.
- Eating, drinking, smoking, chewing gum, taking medications, or applying cosmetics is strictly prohibited in labs. Food and beverage containers shall not be stored in areas containing hazardous materials. Laboratory water or ice sources are not to be used for human consumption.
- Work areas shall be cleaned at the end of each work shift or after completion of an operation.
- Chemicals with harmful vapors should be handled within a properly functioning chemical fume hood. **Compounds having a Threshold Limit Value (TLV) of less than 50 ppm shall be used in a fume hood or other acceptable local exhaust device** unless there is no risk of the material becoming airborne.

- Handle and store glassware with care to avoid damage; never use damaged glassware. Use extra care with evacuated or pressurized glass apparatus - shield or wrap them to contain chemicals and fragments should implosion or explosion occur.
- Use caution when inserting glass tubing into stoppers; lubricate the tubing, and protect the hands. When possible, use a tool such as a Glass-a-Matic to safely insert and remove glass tubing.
- When possible, incorporate waste decontamination and neutralization procedures into the experimental process.
- Implement lock-out/tag-out procedures to prevent re-energizing out-of-service equipment.

Chemical Fume Hood Operating Procedures

- Confirm adequate hood performance prior to use. Never work with a malfunctioning hood or out-of-service hood.
- Lower the hood sash. The hood sash should be kept closed except when adjustments inside the hood are being made. Unattended or potentially explosive operations should be conducted behind a completely lowered sash or safety shield.
- Keep hood storage to a minimum. Place only items necessary for the ongoing operation inside the hood. Do not allow stored items to block vents or air flow; raise large items 2" off the hood surface to facilitate non-turbulent air flow.
- Place all apparatus and materials back at least six (6) inches from the hood sash.
- Leave the hood on when not in use if toxins are stored or if uncertain whether adequate ventilation will be maintained when the hood is off.
- Minimize foot traffic around the hood to avoid generation of competing air currents.
- If a hood malfunctions while in use, shut down work immediately and close the sash. If there is a risk of harmful substances escaping the hood, notify co-workers so that they are not inadvertently exposed, and leave the area. In situations where a hood fails during a high hazard operation, it may be necessary to evacuate an entire building to ensure the safety of occupants. Report all fume hood malfunctions to Physical Plant.

Movement of Chemicals on Site

- Carry glass containers in specially designed bottle carriers or other leak resistant, unbreakable secondary container.
- Open containers of chemicals should never be transported through common areas. Always use closeable primary or secondary containers.
- When transporting chemicals on a cart, use one that is suitable for the load and that has high edges to contain any leaks or spills.
- Whenever possible use freight elevators for transporting chemicals between floors. Do not ride in an elevator when transporting hazardous chemicals, and post notices warning others not to enter an elevator when hazardous chemicals are inside.

Shipping and Receiving Hazardous Chemicals

All employees who are directly involved in shipping and receiving hazardous materials shall be trained, certified, and periodically retrained as required in Title 49 of the Code of Federal Regulations and University Policy UM1296. Except for those specifically excluded by regulations, employees who perform any of the following functions are included in this requirement:

- Load, unload, or handle hazardous materials
- Manufacture, test, recondition, repair, modify, mark, or otherwise represent containers, drums, or packing as qualified for use in the transportation of hazardous materials
- Prepare hazardous materials for transportation

- Ensure safety of transported hazardous materials
- Operate a motor vehicle used to transport hazardous materials

Upon completion of training, including periodic retraining, documentation of such training shall be submitted to Environmental Health and Safety (EH&S). EH&S is responsible for maintaining training records submitted and shall, following review of said documentation for compliance with regulatory requirements, certify that the employee has been trained and tested in accordance with the above requirements.

High Risk Substances and Procedures

When laboratory procedures require the use of particularly hazardous substances or high risk procedures, additional precautions shall be implemented as deemed necessary by the Chemical Hygiene Committee.

Particularly Hazardous Substances

Particularly hazardous substances include OSHA select carcinogens, reproductive toxins (including embryo toxins and teratogens), mutagens, and substances with a high degree of acute toxicity. While OSHA does not specifically define "substances with a high degree of acute toxicity," the following is a well-accepted guideline.

Acute Toxicity Hazard Level				
Toxicity Rating	Oral LD ₅₀ (rats)	Skin LD ₅₀ (rabbits)	Inhalation LC ₅₀ (rats) for 1 hour	
High	<50 mg/kg	<200 mg/kg	<200 ppm	<2000 mg/m ³
Medium	50 - 500 mg/kg	200 mg to 1 g	200 - 2,000 ppm	2,000 - 20,000 mg/m ³

Principal Investigators and laboratory supervisors should pre-plan for the safe use and disposal of particularly hazardous substances. Develop a written SOP and train personnel appropriately. Assure that contingency plans, protective equipment, and materials are available to minimize exposure from accidents. If using significant quantities on a regular basis (3 times a week), consider consulting a physician for medical surveillance. Keep accurate records of the amounts stored, used, the dates of use, and names of workers.

Laboratory personnel should be especially aware of reproductive toxins used in the laboratory. An employee who is planning to start a family or who is already pregnant and working with potential reproductive toxins should consider consulting their physician for guidance on the prudence of working with such materials. Additional precautions as outlined below may be necessary to safely work with reproductive toxins. It is the responsibility of the Principal Investigator and/or laboratory supervisor to determine which of these special precautions are necessary for an individual procedure and to implement use of those precautions. EH&S provides consultative assistance for this task.

Designated Areas

Particularly hazardous substances shall be used in a "Designated Area" which is clearly marked to warn of potential health hazards. A Designated Area may be an entire lab, a portion of a lab, or a piece of equipment such as a restricted access fume hood or glove box.

Personnel shall not enter the Designated Area without proper personal protective equipment and training. Designated Area signs such as the one illustrated at right are available from EH&S.



Protect work surfaces with chemical resistant trays or plastic-backed paper liner. Remove tray or liner at the end of the procedure and dispose of or decontaminate; use chemical decontamination whenever possible. Decontaminate work surfaces immediately after spills and at the end of the procedure. Pre-wet materials before attempting clean-up; never attempt to dry sweep even small amounts of toxic powders. Notify the PI of all exposures or spills.

Ensure that containers of waste (including washings from contaminated glassware) are transferred from the Designated Area in a secondary container. Protect vacuum pumps against contamination by use of scrubbers or high-efficiency particulate air (HEPA) filters, and vent them into the hood. Decontaminate glassware, vacuum pumps, or other contaminated items before removing them from the Designated Area.

Before leaving the Designated Area, remove protective clothing and thoroughly wash hands and all areas of exposed skin. In the event of a splash, remove protective clothing and either dispose of or decontaminate; do not take contaminated clothing home. Store contaminated waste in closed, suitably labeled, impervious containers. Normal laboratory work should not be conducted in a Designated Area until it has been decontaminated and determined to be acceptable for unrestricted use by the Principal Investigator or laboratory supervisor.

Containment

Particularly hazardous substances require proper containment. Conduct procedures that might generate dusts, mists, vapors, or fumes inside a properly functioning fume hood, glove box, or other ventilated enclosure. Trap or scrub excessive quantities of released substances to prevent their discharge within the hood exhaust.

Restrict access to particularly hazardous substances, and store in an a well ventilated area in unbreakable secondary containers. Place these containers on chemical-resistant trays to contain spills. Avoid storing particularly hazardous chemicals on open shelves or counters.

Nanomaterials

While the toxicological properties of nanoparticles have not been fully investigated, initial studies suggest the potential for adverse health effects, especially when the particles are inhaled or there is skin contact. Do not rely on the accuracy of MSDSs for chemicals which have not been evaluated in nanoparticle form; a normally innocuous chemical may not be innocuous at nanoparticle size.

Nanoparticles in dry power form are thought to present the greatest health risk because of the potential for the material to become airborne; therefore, maximum effort must be expended in ensuring that these materials are contained to prevent dispersal into the air. Nanomaterials dispersed into the air also present a serious risk for fire or explosion. Suspension of nanoparticles in liquids offers protection against inhalation exposure, but skin exposure

continues to be a concern. Incorporation of nanoparticles into a solid matrix tends to minimize health hazards; however, there is some evidence that risks persist for bulk materials which are soluble in sebaceous fluids. It is thus prudent to handle all nanomaterials as if they are health hazards. Wear appropriate personal protective equipment (PPE) to prevent skin contact, especially gloves with good chemical resistance to any solvent associated with a suspension of nanomaterials, changing PPE when contaminated.

Since the environmental impact of nanoparticles is still undetermined, care should be taken to avoid discharge of these materials into the environment. Wastes containing engineered nanoparticles should be labeled to indicate the presence of these materials and held for disposal with hazardous waste. Effluent from fume hoods should be filtered through a HEPA filter where it is reasonable to assume that engineered nanoparticles would otherwise be introduced into the environment; alternatives to a HEPA filtered fume hood include Class II, Type B1 or B2, biological safety cabinets.

Prior Approval of Hazardous Laboratory Activities

A permit system shall be used for approval of laboratory activities which present specific, foreseeable hazards to employees. These activities include off-hours work, sole occupancy of building, unattended operations, and hazardous operations. A Chemical Hygiene Permit shall be executed prior to these activities. A permit form is included in the on-line appendices; however, a signed memo from the department chair may serve as a Chemical Hygiene Permit.

Hazardous Operations

Hazardous operations may include use or synthesis of explosives, highly reactive materials, and other high hazard chemicals; operations requiring use of respiratory protection; operations using large quantities of corrosives; etc. The determination of hazardous operations shall be made by the laboratory supervisor and/or the department chair with guidance from EH&S. All hazardous operations are to be performed during a time when at least two persons are present in the laboratory. At no time shall a laboratory worker engage in hazardous operations while working alone in the laboratory.

Off-Hours Work Procedures

Laboratory personnel shall not engage in hazardous laboratory activities after normal working hours (as defined by the department chair) except when permission is granted through a signed Chemical Hygiene Permit.

Sole Occupancy

Except when permission is granted through a Chemical Hygiene Permit, work with hazardous chemicals shall not be performed in the laboratory when the sole building occupant is the person performing the work. Under such conditions crosschecks, periodic checks by Public Safety, closed circuit television, or other measures should be examined for practicality and implemented. Hazardous operations may not be conducted during sole occupancy.

Unattended Operations

When operations are performed which will be unattended by laboratory personnel (continuous operations, overnight reactions, etc.), the following procedures shall be employed:

- The laboratory supervisor shall review procedures to ensure safe completion
- Appropriate signs shall be posted at all entrances to the laboratory
- The overhead lights in the laboratory shall be left on

- Precautions shall be made for the interruption of utility service during the unattended operation (loss of water pressure, electricity, etc.)
- The person responsible for the operation will return to the laboratory at the conclusion of the operation to assist in the dismantling of the apparatus.

Accident and Emergency Preparedness

A written emergency plan shall be developed for each lab and communicated to all personnel. The plan should include procedures to follow in the event of ventilation failure, evacuation, medical emergency, and other likely scenarios. All accidents shall be reported to Employee Safety and Health (ES&H) for investigation. In executing emergency and accident procedures, employees are not to place themselves at risk. Only employees whose job descriptions include requirements to administer first aid are expected to do so.

Chemical Splash to the Eye

- Go immediately to a plumbed eyewash station. Use of bottled eyewash solution is not a suitable substitute for a plumbed eyewash station as they do not contain sufficient fluid to ensure full flushing of the eye.
- Hold eyelids open and flush eyes with water for at least 15 minutes.
- Seek medical attention to ensure that the eyes have not been damaged by either the chemical or the flushing procedure. (Supervisors should ensure that the medical professional is supplied with a copy of the MSDS for the splashed chemical.)

Chemical Splash to Large Area of Body

- Go immediately to the safety shower. Do not attempt to neutralize or otherwise chemically decontaminate the skin.
- Activate safety shower and remove contaminated clothing while drenching the body.
- Drench the body for at least 15 minutes. If possible, bystanders should fabricate a privacy curtain during the decontamination procedure.
- Bystanders should notify other building occupants that a safety shower has been activated so that labs and equipment below can be protected from water damage
- Seek immediate medical attention if more than 9 square inches of skin was exposed, if the substances is absorbed through the skin, if a splash to the eyes occurred, or if a significant inhalation exposure occurred. (Supervisors should ensure that the medical professional is supplied with a copy of the MSDS for the splashed chemical.)

Special Procedures for Hydrofluoric Acid

Hydrogen fluoride ions readily penetrate the skin. Even small exposures can cause severe, deeply penetrating burns and can be fatally toxic. Although exposure to concentrated forms of HF is readily perceived by a burning sensation, symptoms from smaller exposures may not appear for several hours. All personnel working in an area where HF is used or stored should familiarize themselves with these first aid procedures and keep an updated supply of 2.5% calcium gluconate ointment in the work area. EH&S stocks a limited supply of this ointment.

HF Splash to the Skin

- Remove contaminated clothing and flood affected area with water for 5 minutes.
- Apply calcium gluconate gel to all areas of skin involved in the splash; reapply every 20 minutes until medical personnel assess the injury.
- Seek medical attention promptly. Medical evaluation of any HF exposure is imperative!
- Inform emergency medical personnel that calcium gluconate has been administered, and provide them with a hydrofluoric acid MSDS.

Ingestion of Hazardous Chemicals

- Locate MSDS for specific first aid procedure and seek immediate medical attention. (Supervisors should ensure that the medical professional is supplied with a copy of the MSDS for the ingested chemical.)
- Do not induce vomiting without specific instruction to do so. Ingestion injuries may be exacerbated by vomiting.

Inhalation of Smoke, Vapors, Dusts, Mists, or Fumes

- Do not attempt to enter the area if you expect that a life threatening condition exists (e.g., oxygen deprivation, excessive smoke, large fire, etc.).
- Remove victim to a source of fresh air.
- Give artificial respiration and/or CPR as needed.
- Seek medical attention. (Supervisors should ensure that the medical professional is supplied with a copy of the MSDS for the inhaled chemical.)

Chemical Spills

Each lab shall develop a spill control procedure which includes prevention, containment, clean-up, and reporting. Basic spill control kits as well as mercury spill control kits are available from EH&S at no cost or minimal cost. The "Chemical Spill Procedure" found in the on-line appendices lists the basics of spill control and should be posted in the laboratory as a quick and easy reference.

Before attempting to clean up a hazardous material, make sure that you are aware of its hazards, have adequate ventilation, and proper personal protective equipment (at a minimum lab coat, gloves, goggles). Under no circumstances should personnel attempt to clean up a spill if they do not feel that they are adequately trained or equipped to do so. If needed, EH&S is available to assist; such assistance may include utilization of spill response contractors and/or Memphis Fire Department.

Small Spill

In general, spills of less than 1 liter are considered small spills. For small spills which present minimal risk to personal safety, clean up the spill under the laboratory supervisor's guidance in accordance with instructions in the MSDS. The following steps should guide the response to a small spill:

- Alert people in the immediate vicinity of the spill.
- Don proper protective equipment (labcoat, safety goggles, chemically resistant gloves).
- Use spill control kit to neutralize and/or absorb spilled material.
- Collect residue, label, and store as hazardous waste.
- Clean and decontaminate spill area with soap and water or other appropriate means.

Large Spill

If help is needed with a spill that is too large or too hazardous for clean-up by laboratory personnel or others who routinely use the substance, call Police Services at 678-4357 (678-HELP) to request assistance from the Memphis Fire Department or spill response contractor.

- Attend to any injured or contaminated people and remove them from the area.
- Alert others in the laboratory to evacuate the area.
- If spilled material is flammable, turn off ignition sources as you exit the lab.
- Close laboratory door as you exit.

- Report the following to Police Services:
 - ✓ Location of the spill
 - ✓ Quantity released
 - ✓ Chemical name (spell it)
 - ✓ When the spill occurred
 - ✓ Type of assistance needed
 - ✓ Your name and phone number
- Remain available in a safe location to answer questions from emergency responders.

Small Mercury Spills

Environmental Health & Safety provides mercury spill kits at no cost or minimal cost. Small spills (no more than 1 ml, such as a broken thermometer) can be easily cleaned up by laboratory personnel; clean-up of larger spills and those that have contaminated a substantial area should be coordinated by EH&S. The following steps should guide the spill response:

- Use mercury spill kit to clean up mercury droplets.
- Contact EH&S for assistance with recovering small droplets from inaccessible areas.
- Never use a domestic or commercial vacuum cleaner to clean up a mercury spill. These devices dissipate the mercury into microscopic droplets that are exhausted into the room, contaminating the entire area.
- Collect waste in a tightly sealed container, label, and store as hazardous waste prior to chemical waste pick-up.

Environmental Contamination

When spilled hazardous materials enter the soil, sewers, or atmosphere, **the release shall be reported immediately to EH&S at 678-4672 or Police Services at 678-4357**. Appropriate government agencies will be notified when necessary to comply with environmental regulations. Personnel are urged to block floor drains in areas containing hazardous materials. Temporary drain covers prevent accidental releases into sewers while allowing easy removal for drain use.

Fire

Very small fires such as those that can occur while heating a flask of volatile liquid can easily be extinguished by covering the container and smothering the fire. Larger fires require use of fire suppression equipment, either in the form of portable fire extinguishers or professional fire fighting techniques. Only those who have been properly trained in fire extinguisher operation and fire response should attempt to extinguish a fire. Such training is available from Employee Safety and Health. Fires that cannot be put out with a single fire extinguisher require professional fire fighting techniques. If a fire occurs, the following steps should guide your response:

- Keep your back to the door; do not let the fire block your exit route.
- Close laboratory door(s) upon your exit to isolate the fire.
- Activate the building fire alarm system (fire pull box).
- Call Police Services at 678-4357 (HELP) to report the exact location and nature of the fire.
- Evacuate the floor/building/area as appropriate.
- Remain available to police, fire fighters, and other emergency responders.

Medical Emergency

Personnel with severe injuries that require emergency medical assistance should call Police Services at 678-4357 (HELP) for a Memphis Fire Department ambulance.

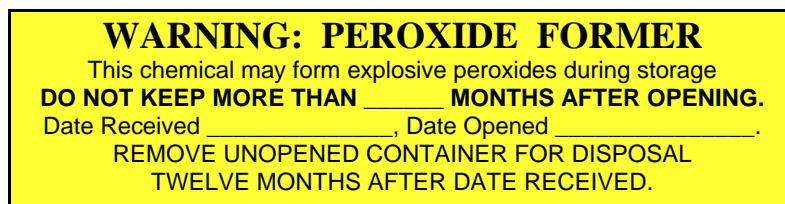
- Remove person from exposure situation if hazardous conditions persist and you are not placed at risk.
- Provide first aid as appropriate.
- Call Police Services to request an ambulance.
- Stay with person until emergency responders arrive.

Chemical Procurement and Storage

Chemical Procurement

The decision to obtain a chemical is a commitment to store, handle, and use the material properly from receipt through disposal. Requests for new chemicals shall be submitted through the department chair. Personnel ordering chemicals are, for waste minimization purposes, obligated to look at existing stocks of chemicals to determine local availability prior to bringing new chemicals on campus. Information on proper handling, storage, and disposal shall be known to all involved personnel prior to procurement of a chemical.

Where possible, chemicals shall be received in a central location within each building or department. Personnel who receive chemical shipments shall be knowledgeable of the proper procedures for receipt. Chemical containers shall not be accepted without accompanying labels, Material Safety Data Sheets (MSDSs), and packaging in accordance with appropriate regulations. All chemical containers shall be dated to indicate when the containers are received and when they are opened. Those chemicals known to form potentially explosive peroxides shall carry a peroxide former label such as the one shown below.



The peroxide former label, available from EH&S, should be completed appropriately and affixed by laboratory personnel upon receipt of peroxide formers. A list of peroxide formers and recommended shelf life may be found in the on-line appendices to this Plan.

DEA Controlled Substances

DEA controlled substances shall not be possessed without a valid license.

Select Agents and Toxins

Federal anti-terrorism laws and associated regulations enacted after September 11, 2001, restrict possession, use, and transfer of certain toxins and biological agents that are capable of harming humans, animals, plants, other living organisms, or the environment. These laws/regulations include penalties of one to five years imprisonment and/or \$250,000 to \$500,000 in fines for individuals and organizations found to be in violation. The lists of CDC Select Agents/Toxins and USDA Plant Pathogens are available for review in the on-line appendices to this plan.

Major requirements of these laws/regulations include: (1) limiting access only to personnel with a legitimate need to handle or use such agents and toxins; (2) submitting for federal background checks the names, and other identifying information, of personnel with a legitimate need to handle or use agents and toxins; (3) denying or limiting access to nationals of

countries determined to support terrorism, persons convicted of serious crimes, and other restricted persons as determined by the U.S. Attorney General; (4) registering facilities with appropriate federal agencies; (5) reporting inventories to appropriate federal agencies; (6) notifying appropriate federal agencies of the release or loss of select agents and toxins; (7) implementing appropriate security measures; and (8) other requirements. Please call EH&S for guidance before attempting to acquire select agents or toxins.

Particularly Hazardous Substances

Particularly hazardous substances shall not be procured without written standard operating procedures in place to assure that persons using such substances are prepared to handle them safely. A form entitled "Purchase Request - Special Hazards Chemicals" is included in the on-line appendices to this Plan for use in procurement approval.

Chemical Storage

Received chemicals shall be immediately moved to an appropriate storage area, if available, or to the laboratory requesting the chemical. Storage areas shall be well-illuminated, with chemical storage maintained below eye level. Large bottles shall be stored no more than three (3) feet from floor level. Storage shelves shall be structurally sound, level, secured to the wall or other source of mass to prevent toppling, have lips or seismic wires to prevent containers from slipping off the edge, and be constructed of material appropriate for the chemicals stored. The storage area shall be accessible during normal working hours and shall be under the control of a person designated by the department chair. Chemical storage areas shall be secured against unauthorized entry.

Limit storage of chemicals at lab benches or other work areas to amounts necessary for one operation or shift. Container size shall be the minimum convenient, and the amounts of chemicals at the lab bench shall be as small as practical.

Chemicals, including compressed gases, shall be segregated by hazard classification and compatibility in a well-identified area with adequate ventilation. Chemical storage rules-of-thumb as outlined below are appropriate in many situations. Laboratories with chemical classes beyond those listed below should consult the on-line appendices for a detailed Chemical Compatibility Chart and chemical segregation scheme.

- Segregate flammable/combustibles and oxidizers
- Segregate mineral acids and bases
- Segregate mineral acids from flammable and combustible materials
- Organic acids may be stored with flammables and combustibles
- Place bottles of acids on acid-resistant trays
- Place containers of potentially incompatible liquids in separate pans designed to contain spills and isolate materials from each other in the event of breakage

Chemicals shall be examined at least annually by laboratory personnel for deterioration and container integrity; the inspection should also determine whether corrosion or other damage has occurred to the storage facility as a result of leaking chemicals. Unneeded items shall be held for proper disposal or redistribution to other labs which have an immediate use for them. Peroxide formers stored for the recommended shelf life shall be withdrawn for disposal or tested for peroxides and re-dated if peroxidation is not evident. Under no circumstances shall peroxide formers be stored or used after the manufacturers expiration date or when the container shows rust or other signs of deterioration.

Compressed gases shall be stored in well ventilated areas, with protective caps securely in place, and secured with chains (preferred) or straps to minimize the probability of falling.

Cylinders of compressed gases having health hazard ratings of 3 or 4 (NFPA criteria) and cylinders of gases with a health hazard rating of 2 with no physiological warning properties shall be kept in a continuously ventilated fume hood or other enclosure. No more than three such cylinders shall be stored in any one enclosure.

Waste Management

It is the responsibility of the generating department to determine if a waste is hazardous before disposal. No chemical shall be disposed in the building solid waste (trash) or down the drain unless it has been determined to be non-hazardous and acceptable for disposal through these means. In addition, liquids shall not be placed in the building solid waste; liquids are unacceptable in the landfill since they can migrate into the ground water. Hoods shall not be used for disposal of volatiles. Indiscriminate disposal of hazardous waste by pouring waste down the drain, adding to mixed refuse for landfill, or evaporation is unacceptable. Recycling or decontamination of wastes should be incorporated into experiments when practicable.

Do not discharge to the sanitary sewer any concentrated acids or bases, any highly toxic, malodorous or lachrymatory substances or anything which may interfere with the biological activity of wastewater treatment plants, create fire or explosion hazards, cause structural damage, or obstruct flow. Neutralize corrosives to acceptable levels before disposal down the drain, and be aware of any contaminants such as heavy metals or reaction products which would make the neutralized solution unacceptable for drain disposal. Maintain records on materials introduced into the sanitary sewer. Consult the "Memphis Sewer Use Ordinance" before discharging anything to the sewer.

Unlabeled containers of chemicals shall be identified before use or disposal. Departments offering unknowns for disposal are currently charged a \$100 disposal fee per container.

Once it has been determined that a waste is hazardous, the following shall apply:

- Store the waste by hazard class in closed containers within a secure area where any leak will not cause harm to the environment. **Do not combine different kinds of waste unless you know that they are compatible and are acceptable for disposal in the combined form.**
- Label the waste with the date accumulation started, identity of the constituents, and the words "HAZARDOUS WASTE."
- Schedule removal of the waste by the University hazardous waste contractor by notifying EH&S that a pick-up is needed. This may be accomplished by submitting a Hazardous Waste Declaration Form available from EH&S.
- Inspect the hazardous waste on a weekly basis and keep a log showing date and time of each inspection, name of the inspector, observations, and any remedial action taken to correct problems. Inspection forms are available from EH&S.
- Install and maintain emergency equipment to be used in case of a spill.
- Post a Chemical Spill Procedure by the nearest phone and in the storage area. Be certain to designate an emergency coordinator who will respond to any emergency situation involving the waste. Fill in the appropriate phone numbers and other information on the Chemical Spill Procedure.
- Keep complete records of all hazardous waste, including generation date, quantities, and kinds of materials.
- Provide training and proper personal protective equipment for personnel who handle or might otherwise be in proximity to the hazardous waste.

Generating departments shall comply with all applicable hazardous waste regulations, file reports with various regulatory agencies, pay applicable fees, and be prepared to pay disposal costs when appropriate. For further guidance consult "A Guide to Hazardous Waste Management" available from EH&S or in your laboratory copy of the "Hazardous Chemical Right-to-Know Notebook." Guidance on operation of satellite accumulation areas is found in the on-line appendices.

Potentially infectious items such as cultures, pathogenic waste, human blood and blood products, sharps, and certain body fluids shall be accumulated, handled, and disposed of in accordance with the University *Biological Safety Program*, exposure control plans, the OSHA Bloodborne Pathogens Standard, and related regulations. In order to avoid potential liabilities due to the appearance of improper disposal, all hypodermic needles, syringes, scalpel blades, needles with tubing attached, and significant quantities of culture dishes shall be disposed through the medical waste or other suitable contractor. Sharps shall be accumulated in properly labeled, puncture resistant, leak proof containers.

Ensure that the chemical hygiene plan for each lab and protocols for each operation include provisions and training for waste disposal.

Empty Containers

To be legally empty, a container which has held an acutely hazardous waste as defined in state and federal regulations shall be triple rinsed using a solvent capable of removing the chemical contained therein, cleaned by another method that is legally acceptable, or by removing and properly handling any inner liner which prevented contact with the container.

Materials rinsed from the container shall be properly handled and disposed.

For other hazardous wastes, all waste must be removed from the container to the extent possible through commonly employed methods of removal for the type of container (e.g., pouring, pumping, etc.). If residue remains, contact EH&S for guidance on container disposal.

Since empty containers represent a significant liability, **labels and other markings shall be obliterated at the time of disposal.** Departments are strongly encouraged to establish procedures to safely break, crush, or puncture empty containers to prevent unwise reuse and reduce the volume of solid waste. **Use extreme care** in breaking glass and always deposit broken glass in rigid, puncture resistant containers to prevent injury of personnel who will handle the waste. **Never** use a torch or other spark producing tool to cut or puncture a metal container which has held a flammable or combustible liquid.

Laboratory Close-Outs and Decommissioning

Prior to the closing a laboratory or other area where hazardous chemicals have been used or stored, departments shall certify that the area has been decommissioned. The principal investigator (PI) is fully responsible for complying with all decommissioning requirements. In the event of death, disability, abrupt termination of employment, or other unplanned event, the department chair becomes responsible for implementing the decommissioning procedure. Department chairs are additionally responsible for oversight of the decommissioning procedure and for certifying that a vacated laboratory space has been properly decommissioned. Researchers who are vacating shared spaces shall ensure that this procedure is implemented for their portion of the lab space.

Departments may incur significant costs as a result of laboratories that have not been properly decommissioned. Departments are responsible for any deficiencies not corrected by the Principal Investigator. Any regulatory actions or fines resulting from improper management

or disposal of any regulated material may also accrue to the department. The Laboratory Decommissioning Form is found in the on-line appendices to this Plan.

Disposal and Transfer of Equipment

Equipment that has held or been potentially contaminated by hazardous materials shall have all such materials removed and the equipment decontaminated prior to disposal or transfer out of the laboratory. Decontamination shall be documented on an Equipment Release Form affixed to the equipment; this form is included in the on-line appendices.

Definitions

Designated Area	An area which may be which may be used for work with “select carcinogens,” reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.
Hazardous chemical	A chemical which represents a health hazard or physical hazard.
Health Hazard	A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term health hazard includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.
Laboratory	A facility where the “laboratory use of hazardous chemicals” occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.
Laboratory Scale	Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. “Laboratory scale” excludes those workplaces whose function is to produce commercial quantities of materials.
Laboratory Use of Hazardous Chemicals	Handling or use of such chemicals in which all of the following conditions are met: (1) Chemical manipulations are carried out on a “laboratory scale” (2) Multiple chemical procedures or chemical are used (3) The procedures involved are not part of a production process, nor in any way simulate a productions process (4) “Protective laboratory practices and equipment” are available and in common use to minimize the potential for employee exposure sot hazardous chemicals
Nanoparticles	Dispersible particles having two or three dimensions greater than 1 nm and less than about 100 nm
Engineered Nanoparticles	Dispersible particles having two or three dimensions greater than 1 nm and less than about 100 nm that make use of properties unique to nanoscale forms of materials. Examples of engineered nanoparticles include carbon nanotubes and fullerenes.

Industrial Nanoparticles	Dispersible particles having two or three dimensions greater than 1 nm and less than about 100 nm that are either produced as a byproduct of industrial operations (e.g., welding fumes) or are nano-sized particles of a material that can also exist in larger sizes (e.g., alumina particles).
Particularly Hazardous Substances	Include OSHA select carcinogens, reproductive toxins (including embryo toxins and teratogens), mutagens, and substances with a high degree of acute toxicity.
Permissible Exposure Limit (PEL)	A regulatory limit on the amount or concentration of a substance in the air. They may also contain a skin designation. PELs are set by OSHA to protect workers against the health effects to exposure to hazardous substances. PELs are enforceable.
Physical Hazard	A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.
Select Carcinogen	Any substance which meets one of the following criteria: (1) It is regulated by OSHA as a carcinogen (2) It is listed under the category, "known to be carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (3) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions) (4) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: (A) After inhalation exposure of 6-7 hours per day, 5 days per week for a significant portion of lifetime to dosages of less than 10 mg/m ³ (B) After repeated skin application of less than 300 (mg /kg of body weight) per week: (C) After oral dosages of less than 50 mg/kg of body weight per day
Threshold Limit Value (TLV)	Developed by the American Conference of Governmental Industrial Hygienists (ACGIH) to assist in the control of health hazards. TLVs are guidelines intended for use in the practice of industrial hygiene, to be interpreted and applied only by a person trained in the discipline; they are not developed for use of legal standards as a supplement to their OSHA programs.

List of On-line Appendices

Carcinogen List

Chemical Hygiene Permit

Chemical Hygiene Training Record

Equipment Release Form

Guide to Hazardous Waste Management

Hazardous Waste Satellite Accumulation Area Guide

Hazardous Waste Inspection Checklist for Satellite Accumulation Areas

Laboratory Decommissioning Form

Laboratory Specific Standard Operating Procedure Form

Personal Protective Equipment Assessment Tool

Purchase Request for Special Hazard Chemicals

U of M On-line MSDS Collection

Unwanted Chemical Declaration Form

Waste Determination Process for Spent Chemicals

Waste Determination Process for Unused Chemicals

Weekly Hazardous Waste Inspection Log

Workplace Hazard Assessment Guide for PPE