

CHEMICAL HYGIENE PLAN



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List of Acronyms

CHO	Chemical Hygiene Officer
IBC	Institutional Biosafety Committee
MSDS	Material Safety Data Sheets
MSU	Missouri State University
OSHA	Occupational Safety & Health Administration
PI	Principal Investigator
PPE	Personal Protective Equipment
RSO	Radiation Safety Officer
SOP	Standard Operating Procedure

Emergency Phone Numbers

Fire/ Police/ Emergency Medical	911
Poison Control Center	800-222-1222
MSU Safety & Transportation	836-5509
Taylor Health	836-4000
MSU Environmental Management	836-8334/ 836-3108

1.0 PURPOSE & SCOPE

The purpose of the Chemical Hygiene Plan is to establish procedures to protect all employees from health/physical hazards associated with the use of hazardous chemicals in the laboratory. This plan was developed in accordance with the US Occupational Safety & Health Administration's (OSHA) Laboratory Standard (29 CFR 1910.1450), and applies to all Missouri State University (MSU) Chemistry Department faculty, staff, student employees, and associates working with or around laboratory operations involving hazardous chemicals.

Each laboratory employee is expected to be familiar with and operate in accordance with the procedures outlined in this plan. The plan will be available for review; a copy will be kept in the following location: Temple 403, Chemistry Department Stockroom. Material Safety Data Sheets (MSDS) for the department are also located in the Stockroom.

A list of specific terms and definitions used in this plan is provided in Appendix B.

2.0 RESPONSIBILITIES

Department Head: The department head is responsible for chemical hygiene in the laboratory. This person shall insure:

1. Laboratory employees know and follow the chemical hygiene rules.
2. Appropriate training is provided and protective equipment is available and in working order.
3. Facilities and training for use of any material being ordered are adequate.
4. Routine and periodic checks are conducted of emergency equipment, chemical hygiene, and departmental housekeeping.

Laboratory Employee: Each University/laboratory employee is responsible for planning and conducting all operations in accordance with the chemical hygiene procedures, and developing good personal chemical hygiene habits. Principal investigators with direct oversight of laboratories are responsible for ensuring the health and safety of subordinate staff and students in the laboratory setting, allowing no students to work in their lab prior to appropriate training requirements.

Chemical Hygiene Officer: The Director of Environmental Management serves as MSU's Chemical Hygiene Officer (CHO). The Lab and Stores Supervisor serves as the Chemistry Department's CHO. Responsibilities of the CHO include:

1. Monitor use and disposal of chemicals used in the laboratory setting.
2. Assist departments and individual laboratories in developing precautions and adequate facilities.
3. Keep up to date on the current legal requirements concerning regulated substances.
4. Periodically review the Chemical Hygiene Plan and update as appropriate.

Departmental CHOs will have immediate control and responsibility for chemical safety within their laboratories.

3.0 GENERAL LABORATORY PROCEDURES

The following rules are appropriate for essentially all laboratory work with chemicals:

- Employees shall act in a professional manner at all times.
- Horseplay and practical jokes are forbidden.
- Avoid working alone.
- Know as much as possible about the chemical you are handling. Acquire information from container labels, MSDS, literature, or discussing chemical properties with peers.
- Employees shall be aware of the location and proper operation of laboratory safety equipment.
- Use appropriate personal protective equipment (PPE) based on the hazards of the materials in use. Additional detail on PPE use and selection is provided in Section 4.0.
- Avoid 'routine' exposures:
 - i. Take necessary precautions to avoid skin contact with chemicals.
 - ii. Do not smell or taste chemicals.
 - iii. Never pipette by mouth. Use a vacuum or a pipette bulb.
 - iv. Apparatus that may discharge toxic chemicals must be vented into local exhaust devices.
 - v. Choose only those chemicals for which the quality of the available ventilation system is appropriate.
- Eating, drinking, smoking, gum chewing, and cosmetic application are not permitted.
- Food or drinks may not be stored in a refrigerator with chemicals. Glassware or utensils that are used for laboratory operations may not be used for storage, handling, or consumption of food or beverages.
- Ice machines or containers that have been used for storage of chemicals shall not be used for food storage.
- Confine long hair and loose clothing. Wear closed-toe shoes at all times; open-toe shoes are prohibited in the laboratory. Low-heeled shoes and pants are preferred.
- Handle and store lab glassware with care to avoid damage; do not use chipped or cracked glassware.
- Use equipment only for its designated purpose.
- Hands shall be washed before using the restrooms and before eating or smoking. Areas of exposed skin (e.g. forearms) should be washed frequently if there is potential of contact with chemicals.
- Be alert to unsafe conditions and report them to your supervisor or department head.

- Chemical fume hoods should be used for any operations which might result in release of toxic chemical vapors or dust.
- Proper procedures for transporting chemicals around department are using secondary containers, such as using rubber or plastic bottle carriers to transport corrosive materials.
- Any food materials, opened or closed, are considered chemical supply when brought into a laboratory. Label all with “not for human consumption”.
- Only well understood reactions shall be permitted to run unattended. Lights should be left on and appropriate signage placed on the door. Provisions for containment of toxic substances in the event of a utility service failure (such as cooling water) to an unattended operation should be established.
- Accidents and spills:
 - i. Eye contact- promptly flush eyes with water for a minimum of 15 minutes and seek medical attention.
 - ii. Skin contact- promptly flush affected area with water and remove any contaminated clothing. If symptoms persist after washing, seek medical attention.
 - iii. Ingestion-drink large amounts of water unless contraindicated by the MSDS or a physician.
 - iv. Immediately clean up any spills; notify your supervisor or the Environmental Management Department if assistance is needed.
- Visitors are to be escorted by a laboratory employee and are the responsibility of that employee. University staff members performing routine, daily duties are excluded from this requirement.

3.1 HOUSEKEEPING

1. Access to exits, emergency equipment, and utilities must never be blocked. Coats, bags, and other personal items must be stored in the proper area, not on the bench tops or in the aisle ways.
2. Properly label chemicals and equipment for use and storage. Repair or replace any damaged labels immediately. Secondary containers must be labeled with the chemical name, manufacturer’s name, hazard class, and any other special warnings.
3. The floors should be cleaned on a regular basis. Promptly wipe up all liquid spills and ice on the floor.
4. Keep work areas clean and uncluttered. Bench tops and hoods should remain clear of broken glass, spilled chemicals, paper litter, etc.
5. Chemical hazards should be maintained at least two inches from the edge of the bench tops.
6. Do not conduct unattended experiments without the authorization and prior approval of the Laboratory Supervisor or PI.
7. Do not store materials or chemicals on the floor.

8. Do not block the sink drains. Place rubber matting in the bottom of the sinks to prevent breakage of glassware and avoid injuries.
9. Wear appropriate gloves to clean glassware. Handle and store laboratory glassware with care. Promptly discard cracked or chipped glassware.
10. Clean up work areas at the end of the operation or day.
11. Properly dispose of broken glass and sharps (i.e., needles and razor blades). If broken glassware is contaminated with a hazardous substance, the glassware must be treated as a hazardous substance.
12. To avoid accidents, drawers and cabinets must be kept closed.
13. Properly dispose of all waste chemicals. Never pour waste chemicals down the drains.
14. It is the responsibility of the Teaching Assistant of each lab to make sure all equipment and glassware are put away, bench tops and hoods are cleaned, and no unlabeled chemical residues are left in glassware or on tables before the following lab starts.

3.2 INSPECTIONS

Formal housekeeping and laboratory inspections will be conducted on a regular basis by the Chemical Hygiene Officer and/or the Departmental Safety Committee. Informal inspections will be conducted by the CHO on a monthly basis and will be unannounced.

4.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

The department head or PI (or designee) shall be responsible for the selection of PPE, acquiring the proper PPE, maintaining availability, and establishing cleaning and disposal procedures. Basic PPE for MSU laboratories consists of lab coats, eye protection, and gloves. PPE shall be inspected before each use and must be removed before leaving laboratory areas.

Eye Protection

Eye protection will be worn by everyone entering the laboratory. Eye protection used in MSU laboratories must at a minimum meet the requirements of ANSI Z87.1. Chemical splash goggles are recommended when working with chemicals, glassware, or heat. Face shields are recommended when transferring or pouring acidic or caustic materials.

Contact lenses should not be worn in the laboratory; chemicals can be concentrated under contact lenses and contact lenses will interfere with eye flushing in case of emergency. If the employee needs to wear contact lenses (e.g. if the vision

deficiency cannot be corrected with glasses), then chemical splash goggles must be worn over the contact lenses.

Gloves

Appropriate chemical resistant gloves shall be worn whenever the potential for hazardous skin contact exists. The material safety data sheet for the substance or glove selection charts should be referenced for glove selection. Special use gloves may include the use heat resistant gloves for handling hot objects or abrasion resistant gloves (e.g. Kevlar cut resistant gloves, leather gloves) for handling broken glass or for other potentially abrasive situations. Note that these special use gloves are not chemical resistant, and must NOT be worn when handling chemicals.

Remove gloves if they become damaged during use, or before touching other surfaces (e.g. door knobs, faucet handles).

Clothing

Laboratory coats should be worn when working in the laboratory. Lab coats should be inspected for damage, deterioration, or contamination prior to each use, and cleaned or replaced as necessary. Remove the lab coat immediately if significant contamination occurs.

4.1 HEARING PROTECTION

1. Hearing protection devices (e.g. ear plugs) are required whenever employees are exposed to an 8-hour time-weighted average (TWA) of 85 dBA or greater.
2. An 85 dBA or greater TWA lab environment would trigger mandatory compliance with all facets of OSHA's Occupational Noise Exposure Standard (29 CFR 1910.95).

4.2 RESPIRATORS

1. Prior to the use of any respirators, a review of all optional engineering controls should be conducted to try to eliminate the need for respirator use.
2. If no engineering control is available, any respirator use must be in accordance with the department's Voluntary Respirator Use program [referencing 29 CFR 1910.134(c)(2)].

4.3 TRAINING

1. Employees shall not use any PPE until they have received instruction on the proper selection, use, and limitations of the equipment.
2. It is the responsibility of the department head (or PI) to ensure proper training has been provided.

5.0 HAZARD IDENTIFICATION

1. All chemical containers must have legible label describing contents.
2. Unlabeled products should not be stored anywhere in the department.
3. Labels on incoming containers of hazardous chemicals shall not be removed or defaced.
4. *Material Safety Data Sheets (MSDS)*. Available via:
 - i. University website
(<http://www.missouristate.edu/environmental/msds.asp>)
 - ii. Main hardcopy file—located in Temple 403.
5. A hazard review of new materials not previously used in the laboratory should be completed before actual handling has begun. This review should be conducted by the PI and laboratory worker.
6. Chemical substances developed in the laboratory shall be assumed to be hazardous in the absence of other information.

If a chemical substance is produced in the laboratory for another user outside Missouri State University, the MSDS and labeling provisions of the OSHA Hazard Communication Standard apply. The CHO must be contacted to ensure these requirements are met.

6.0 ENVIRONMENTAL MONITORING

Laboratory employee exposures shall not exceed permissible exposure limits specified in 29 CFR 1910, Subpart Z.

1. Employee exposures to any substance regulated by an OSHA standard shall be measured when there is reason to believe that exposure levels routinely exceed the action levels.
2. The CHO should be consulted for assistance with environmental monitoring.
3. The CHO will notify employees of monitoring results.

7.0 EMERGENCY EQUIPMENT

7.1 GENERAL

Emergency equipment is located throughout the various laboratories and stockroom. Laboratory Supervisors are responsible to ensure that each laboratory employee is familiar with the location, application, and correct ways to operate the following equipment:

Fire extinguishers*	Fire Blankets
Fire alarms	Fire Doors
Safety showers	Smoke detectors
Eye wash stations	First aid kits
Chemical spill kits	

**Fire extinguisher training for laboratory workers is highly recommended.*

7.2 SAFETY SHOWERS/ EYEWASH STATION

1. Safety showers and eyewashes should be within the work area for immediate emergency use.
2. Inspections
 - a. Weekly
 - Safety showers and eyewash stations should be flushed weekly by a laboratory employee.
 - b. Monthly
 - The Environmental Management Department will conduct monthly inspection of all safety showers and eyewash stations.

7.3 FIRE EXTINGUISHERS

1. Fire extinguishers are located within each laboratory.
2. Access must be maintained and the location should be marked as appropriate.
3. The fire extinguisher type and size shall be selected for the appropriate hazards.
4. Monthly inspections conducted by designate:
 - Each extinguisher is in its designated location.
 - Unimpeded access is maintained.
 - The pin is in place and attached with an unbroken wire.
 - Check to ensure the indicator gauge is full.
 - Check for evidence of physical damage
5. Annual inspections conducted by outside contractor via Safety and Transportation Department:
 - Copies of annual inspections and scheduled maintenance are maintained in the Safety and Transportation Department.

7.4 FIRST AID KITS

1. First aid kits should be available and maintained for treatment of minor injuries or for short-term emergency treatment before getting medical assistance.
2. PI's have oversight on inspecting and maintaining first aid supplies in their respective laboratories.
3. Stockroom manager oversees the first aid kit available in the stockroom.

8.0 EMERGENCY PROCEDURES

8.1 INJURIES

1. For serious injuries, contact Public Safety at 911 or 836-5509 immediately.
2. Do not move an injured person unless he or she is in danger of further harm.
3. If chemicals have been spilled on the body or splashed in the eyes, flood the exposed area(s) with running water for fifteen minutes, and remove contaminated clothing.

8.2 CHEMICAL RELEASES

In addition to the following procedures, specific chemical spill information may be found on container labels and MSDSs.

1. Major Spills
 - a. Alert nearby personnel.
 - b. Sound the building alarm and evacuate the building.
 - c. Confine the spill if possible.
 - d. Contact Public Safety at 911 immediately.
2. Minor Spills – Liquids
 - a. Confine the spill to a small area.
 - b. Avoid breathing vapors of the spilled material.
 - c. Clean up the spill and label per Section 17.4.
 - d. Follow proper waste disposal procedures (Section 17.4).
3. Minor Spills – Solids
 - a. Sweep solids of low toxicity into a dust pan and place into proper container for disposal (Section 17.4).
 - b. Cleaning minor spills of toxic solids will require cleanup measures as prescribed on the chemical's MSDS.
4. Leaking Compressed Gas Cylinders
 - a. If the leak cannot be stopped by tightening the valve, the supplier (Praxair Distribution) shall be contacted as soon as possible.
 - b. If it can be done so safely, remove and isolate the cylinder into a well-ventilated safe area. Notify Public Safety at 911.

For more information see Hazardous Waste/Hazardous Materials Contingency Plan.

8.3 FIRES AND EXPLOSIONS

1. A fire in a small vessel oftentimes could be suffocated by covering the vessel with an inverted beaker or a watch glass. Employees trained on the usage of fire extinguishers may use an extinguisher to put out a small fire; direct the discharge at the base of the flame using a sweeping motion. Consultation of the extinguisher's label is necessary to ascertain the class(es) of fires it is effective against:
 - Class A fires: Ordinary combustible solids such as paper and textiles.
 - Class B fires: Flammable liquids.
 - Class C fires: Electrical fires.
 - Class D fires: Reactive metals.
2. The following emergency procedures shall be followed in the event of larger fires or explosions:
 - a. Alert nearby personnel.
 - b. Confine the emergency if possible.
 - c. Call Public Safety at 911 immediately.
 - d. Sound the building alarm and evacuate the building.

9.0 ACCIDENT REPORTING/ RECORDKEEPING

1. Injuries requiring medical attention must be reported immediately and appropriate medical treatment provided.
2. Report accidents resulting in injury or property damage, such as spills to Public Safety and Department Safety Chair.
3. Accident/incident records shall be accumulated and maintained the by Departmental Safety Chair/CHO. Occupational medical records shall be retained for the duration of employment plus thirty years.

10.0 MEDICAL PROGRAM

1. Medical surveillance, including medical consultation and follow-up, shall be provided under the following circumstances;
 - a. Where exposure monitoring is over the action level for an OSHA regulated substance that has medical surveillance requirements.
 - b. Whenever a laboratory employee develops signs or symptoms that may be associated with a hazardous chemical resulting from exposure in the laboratory.
 - c. Whenever a spill, leak, or explosion results in the likelihood of a hazardous exposure, as determined by the CHO.
2. All examinations shall be provided by a licensed physician or under the direct supervision of a licensed physician, at no cost to the employee, without loss of pay, and conducted at a reasonable time and place. Except in extreme cases, student employees should be referred first to Taylor Health and Wellness Clinic.
3. Where medical consultations or examinations are provided, the examining physician shall be provided with the following information:
 - a. The identity of the chemical(s) to which the employee(s) may have been exposed; *very likely the attending physician will seek a copy of the MSDS for the chemicals—supervisors should make arrangements to forward these documents promptly.*
 - b. A description of the conditions under which the exposure occurred.
 - c. A description of the signs or symptoms of exposure that the employee is experiencing.
4. For examinations or consultations provided to employees, a written opinion from the examining physician shall be obtained by individuals representing Taylor Health and Wellness and shall include the following:
 - a. Recommendations for further medical follow-up.
 - b. Results of the examination and associated tests
 - c. Any medical condition revealed that places the employee at an increased risk of exposure to a hazardous substance found in the workplace.
 - d. A statement that the employee has been informed of the results of the examination or consultation.

**Accidents or injuries that occur in the laboratory and require medical attention must be treated immediately. Chemical incidents must be reported promptly to the Safety and Transportation Department 836-5509.*

11.0 STANDARD OPERATING PROCEDURES

This section provides generalized standard operating procedures (SOPs) for the laboratory. Each organizational entity or PI should develop written SOPs specific to their operation. Safe work practices and selection and use of personal protective equipment should be an integral part of the lab safety procedures.

11.1 PLANNING CHEMICAL LABORATORY EXPERIMENTS

1. Seek information about potential hazards, plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation.
2. List all possible reactions including side-reactions before beginning.
3. Follow recognized safe practices concerning protective equipment, housekeeping, handling of hazardous chemicals, and utilization of equipment as outlined in this chemical hygiene plan.
4. If conducting an unknown reaction, always start with small quantities of material and carefully observe reaction characteristics such as temperature, color, viscosity, and physical state.
5. Obtain safety (exposure routes) and chemical characteristics information (pH, flash point, vapor pressure, etc) about reactants and by-products.
6. As necessary and applicable, provide adequate cooling, ventilation, pressure relief, and gas purging. Isolate the reactive vessel and conduct frequent inspections of equipment during reaction. *Do not leave a hazardous system unattended.*
7. The lab worker needs to pre-plan the reaction itself; common questions are "How violent will the reaction be?", "What is the effect of catalysts or inhibitors?" "Will water or air affect the reaction?"
8. SOPs should be in place for electric power failure, cooling system failure, water and/or air leaks into the system, or release/spill of reaction contents.
9. Note that explosions, fires, or asphyxiation could be caused by the accidental combination of potentially dangerous substances.

12.0 CHEMICAL PROCUREMENT AND STORAGE/INVENTORY

12.1 PROCUREMENT

1. Departments are responsible for procurement of chemicals within their laboratories via approval from department head or designee. *Prior* to purchasing, the following must be considered:
 - a. Proper storage and handling procedures;
 - b. Proper disposal procedures;
 - c. Adequate facilities to safely handle the hazardous chemicals;
 - d. Adequately trained personnel.
2. Before a substance is received, information on proper handling, storage, and disposal shall be known to those who will be involved.

3. No container shall be accepted without an adequate identifying label. The label shall include as a minimum the substance name, an appropriate hazard warning, and specific target organ effects.
4. All containers must be received in a central location, the Chemistry Stockroom.
5. Purchasers are encouraged to check the Chemical Exchange Program under the Environmental Management website for surplus chemicals that may be available. Materials requested from Chemical Exchange are provided at no cost to the user.

12.2 STORAGE/INVENTORY

1. Minimize storage and working amounts of hazardous chemicals.
2. All chemical containers must have a legible firmly attached label, containing the following information: chemical name written out, concentration or purity, hazard information, name of manufacturer or name of preparer, and date of preparation or received. See Appendix D for NFPA guidelines.
3. Chemicals shall be stored in containers that are chemically compatible.
4. Chemical reagents shall be kept in closed containers when not in use.
5. All flammable substances with NFPA rating of 3 or 4 shall be stored safely in designated storage units (e.g. flammable storage cabinet) and corrosives in corrosive cabinet when possible. Poisons with a NFPA rating of 3 or 4 shall be stored in a locked cabinet in the storeroom.
6. Store in appropriate designated locations; hazardous chemical storage in offices is prohibited.
7. Compressed gas cylinders must be secured by three points of contact at all times (chain, wall or other cylinder). Caps shall be in place on cylinders not in use.
8. Incompatible chemicals must be segregated; a partial listing of incompatible chemicals is included in Appendix C.
9. Departments are responsible for maintaining and updating an inventory of chemical stocks. Inventories should be available upon request to Environmental Management.
10. Surplus, out-of-date, or no longer needed chemicals should be removed from the laboratory. Examine stored chemicals annually for deterioration and chemical integrity. Chemicals that are still viable should be submitted to the chemical exchange program; out-of-date or adulterated chemicals should be submitted for disposal per Section 17.4.
11. Label all chemicals with a received date.
12. Do not store chemicals under a fume hood, which decreases the efficiency of the fume hood.
13. Chemicals should not be stored on the floor without secondary containment.
14. Flammables can only be stored in a refrigerator that is explosion proof.
15. Never store chemicals over or near a sink.

13.0 GENERAL CHEMICAL HANDLING PROCEDURES

General chemical handling procedures, including recommended storage and control methods, are included in the table below. This should be considered a general guide only, and is not a substitute for specific chemical information available from product labels and MSDSs.

Table 1
General Chemical Handling Procedures

Flammable Liquids/Solvents			
<i>Hazards</i>	<i>Storage</i>	<i>Controls</i>	<i>Examples</i>
<ul style="list-style-type: none"> • Fire • Respiratory • Skin contact • Eyes 	<ul style="list-style-type: none"> • Store in approved flammable cabinet • Maintain 'in use' quantities at a minimum 	<ul style="list-style-type: none"> • Wear proper PPE • Use fume hood • Proper grounding when transferring to/from metal containers • Clean spills immediately 	Acetone Ethanol Isopropyl Alcohol Hexanes
Corrosives			
<i>Hazards</i>	<i>Storage</i>	<i>Controls</i>	<i>Examples</i>
<ul style="list-style-type: none"> • Respiratory • Skin contact • Eye contact 	<ul style="list-style-type: none"> • Utilize secondary containment • Transport in chemical carrier • Store away from incompatibles • Clean drip tray often 	<ul style="list-style-type: none"> • Wear proper PPE • Flush any body contact areas with water immediately • When diluting, <i>always add acid/base to water</i> 	Nitric Acid Sulfuric Acid Sodium Hydroxide Hydrochloric Acid
Toxic Materials			
<i>Hazards</i>	<i>Storage</i>	<i>Controls</i>	<i>Examples</i>
<ul style="list-style-type: none"> • Inhalation • Ingestion • Potential for skin absorption 	<ul style="list-style-type: none"> • Maintain minimum quantity necessary • Store as indicated by manufacturer or supplier 	<ul style="list-style-type: none"> • Use fume hood as possible • Clean spills immediately 	Lead Mercury Ethidium Bromide Methylene Chloride

Reactive Materials			
<i>Hazards</i>	<i>Storage</i>	<i>Controls</i>	<i>Examples</i>
<ul style="list-style-type: none"> • May react violently with water • Pyrophors: potential ignition if exposed to air 	<ul style="list-style-type: none"> • Store as indicated by manufacturer or supplier • Store pyrophors in inert gas or under oil (exclude ambient air) 	<ul style="list-style-type: none"> • Wear proper PPE • Take precautions per manufacturer • Use fume hood • Use blast shield when necessary 	Sodium metal Potassium metal Phosphorous

Compressed Gases			
<i>Hazards</i>	<i>Storage</i>	<i>Controls</i>	<i>Examples</i>
<ul style="list-style-type: none"> • May be flammable, toxic, or corrosive • Cylinders contain large amounts of stored energy; may cause serious injury/ damage 	<ul style="list-style-type: none"> • Store in upright position, secured to permanent structure with strap or chain • Keep caps in place when not in use 	<ul style="list-style-type: none"> • Transport with cap in place, using gas cylinder dolly • Use only appropriate fittings and regulators • Use check valves to avoid cross-contamination • Open valves slowly and carefully 	Hydrogen Argon Nitrogen Carbon Dioxide

Reproductive Toxins/ Carcinogens/ High Acute Toxicity Chemicals			
<i>Hazards</i>	<i>Storage</i>	<i>Controls</i>	<i>Examples</i>
<ul style="list-style-type: none"> • Chromosomal damage/ adverse reproductive outcomes • Effective exposure response times very short 	<ul style="list-style-type: none"> • Store in isolated and secure area • Maintain minimum quantity necessary 	<ul style="list-style-type: none"> • Work in designated area (refer to Section 14.0) • Wear proper PPE • Utilize adequate engineering controls (fume hood/ glove box) 	Arsenic Benzene Vinyl Chloride

Peroxide Formers			
<i>Hazards</i>	<i>Storage</i>	<i>Controls</i>	<i>Examples</i>
<ul style="list-style-type: none"> • Shock sensitive and may detonate when peroxide crystals are formed 	<ul style="list-style-type: none"> • Limit exposure to air, light, heat, moisture and contamination from metals • Label bottles with date opened and use test strips often 	<ul style="list-style-type: none"> • When possible, purchase with a peroxide formation inhibitor • Do not touch or open when white crystals are observed 	Tetrahydrofuran Diethyl ether

Cryogenics			
<i>Hazards</i>	<i>Storage</i>	<i>Controls</i>	<i>Examples</i>
<ul style="list-style-type: none"> • Cryogenic burns can be caused by splashing or spills • Cylinders contain large amounts of stored energy; may cause serious injury/ damage • Asphyxiation is possible if there is not adequate ventilation 	<ul style="list-style-type: none"> • Liquid helium must be kept in specially designed storage or transport vessels • Liquid nitrogen may be transported using a proper dewar for cryogenics 	<ul style="list-style-type: none"> • Proper PPE (cryo gloves, close toe shoes, and goggles) • Sufficient ventilation • Proper use of storage dewars 	Liquid nitrogen liquid helium

13.1 SUBSTANCES OF HIGH CHRONIC/HIGH ACUTE TOXICITY

RADIOACTIVE MATERIALS

The use of radioactive sources and radiation-producing equipment is strictly regulated by the Nuclear Regulatory Commission (NRC), Missouri Department of Health and Senior Services' (MDHSS), and Missouri Radiation Control Program (MRCP). Radioactive sources at Missouri State University are licensed through the NRC; users of any radioactive source or radiation-producing instrument are responsible to notify the University's Radiation Safety Officer (RSO) for authorization before purchasing or bringing any radiation source on campus.

14.0 DESIGNATED AREAS

A designated area must be established for work with "select carcinogens", reproductive toxins, and substances that have a high degree of acute toxicity. The following procedures must be developed for all work with select carcinogens, reproductive toxins, and substances of high acute toxicity:

- a. The establishment of a 'designated area'. This may be an entire laboratory or a device in the laboratory, such as a hood. This area must be clearly marked.
- b. Required approvals for conducting this project.
- c. Control equipment in place as required (e.g. fume hood/ biological safety cabinet).
- d. Proper storage procedures.
- e. PPE availability.
- f. Retention of records on amounts of these substances on hand, and the names of workers involved.
- g. Spill prevention, emergency response, decontamination, and waste disposal.

15.0 OPERATIONS REQUIRING PRIOR APPROVAL

Certain laboratory operations are of special concern because of the potential hazards associated with them (for example: rDNA work requiring approval from Institutional Biosafety Committee, or working with radioisotopes requiring by formal approval from the NRC). In these instances laboratory personnel are instructed to obtain prior approval from the appropriate committee or agency prior to commencing the operation.

For this department, these procedures include the principal investigator first contacting the CHO for approval and additional information.

16.0 VENTILATION

16.1 GENERAL GUIDELINES

General laboratory ventilation should provide air flow into the laboratory from non-laboratory areas and out to the exterior of the building.

1. All laboratory doors should remain closed, except when used for entrance or egress.
2. All reactions that produce unpleasant and/or potentially hazardous fumes, vapors, or gases shall be run with local exhaust ventilation (e.g. fume hoods).
3. Reactions with corrosive fumes should be conducted in a hood lined with corrosion-resistant material.
4. The sash of the hood should be lowered to within 6" of the floor of the hood when in use. This achieves an effectiveness of the hood ventilation system as well as providing a barrier between the chemical reaction and worker.

16.2 FUME HOOD MAINTENANCE AND INSPECTIONS

Daily (or prior to each use) lab employees working with chemicals should do the following:

- Visually inspect the hood area and remove storage and other visible blockages.
- Check that the pressure gauge (manometer) is functioning.

The department will be responsible to see that hoods are inspected every 3 months to verify that face velocities are adequate to meet manufacturer recommendations. Work orders should be submitted to Facilities Maintenance for hoods that appear to be malfunctioning or do not meet adequate manufacturer face velocities.

16.3 VENTILATION FAILURE

In the event of a ventilation equipment failure, lab employees will:

1. Shut down all experiments or chemical operations, if possible.
2. Notify Facilities Management to initiate repairs immediately.
 - a. Improperly functioning equipment, out of service equipment, and equipment under repair shall be locked and tagged out and not restarted without the approval of the Facilities Maintenance.
3. If the failure will result in a hazardous situation such as the release of a hazardous vapor to general areas of the building, contact Public Safety and evacuate the area.

17.0 WASTE DISPOSAL

17.1 BROKEN GLASS

Broken glass (e.g. beakers, pipettes, flasks) should be promptly swept up and disposed in designated broken glass containers. If the container spills chemical contents, refer to Section 17.4.

17.2 BROKEN THERMOMETERS

The University strongly encourages the removal of all mercury thermometers in order to eliminate the potential for mercury exposure to laboratory workers. Standard mercury thermometers may be exchanged for alcohol thermometers at no cost; to exchange/dispose of mercury thermometers contact the Environmental Management Department.

1. Entities that choose to keep mercury thermometers are expected to have mercury spill kits on hand, and to train laboratory workers in the use of the spill kits. Contact Environmental Management in the event of a mercury thermometer break.
 - a. Thermometer pieces *and* all mercury cleanup material must be placed in a suitable container and disposed per Section 17.4.
2. Glass from broken alcohol thermometers should be placed in designated containers per Section 17.1. No other cleanup or notification is necessary.

17.3 CHEMICAL WASTES

Employees working in the laboratory are responsible for ensuring chemical wastes are managed properly while they are in the lab. In-lab waste storage areas, or Satellite Accumulation Areas (SAAs), are regulated by Federal/State law. General procedures for waste containers in SAAs are listed in Section 17.4.

17.4 WASTE DISPOSAL PROCEDURES

To properly manage hazardous waste with respect to treatment, transportation, and ultimate disposal, it is necessary to identify the waste and its properties. Chemical analysis for identification purposes is time-consuming and costly. At Missouri State University, the Environmental Management Office utilizes the knowledge and expertise of those involved in the generation of waste to aid in its identification. In order to enable Environmental Management to effectively classify and manage these wastes, the cooperation of everyone involved is essential.

1. Containers
 - Chemical waste must be placed in appropriate containers, and containers must remain sealed at all times, except when adding waste.
 - Flasks, beakers, and other non-sealing lab items are not considered appropriate waste containers and should never be labeled with the word "waste".

2. Labeling
 - Labels must be securely affixed to the container.
 - Information on the label must include name of class (or Lab Supervisor) generating the waste, start accumulation date, room number and all chemicals in the waste.
 - List chemicals out by name, do not label by chemical formula or with structures, etc.
3. Disposal
 - Fill out the web submission form (www.missouristate.edu/environmental/24684.htm) to make arrangements for hazardous chemicals to be removed.
 - Do not dispose of hazardous chemicals in the trash or flush down the drain. Sink flushing or discarding of non-hazardous chemicals shall be evaluated on a case-by-case basis via direction from the CHO or department-appointed designee.
 - Fume hoods may not be used as a vehicle for releasing volatile chemicals.

18.0 EMPLOYEE TRAINING

All laboratory employees will receive training related to the hazards of chemicals present in their work area. Training will be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present, and prior to assignments involving new exposure situations. The training shall be provided by the PI and/or CHO of department.

The training should include the elements covered in this Chemical Hygiene Plan as well as any procedures unique to the specific laboratory. Training topics include:

- General laboratory procedures
- Selection and proper use of PPE
- Emergency equipment use/ emergency procedures
- Standard operating procedures
- General chemical handling guidelines
- Use of reference materials, including the chemical hygiene plan and MSDSs
- Use of engineering controls as a barrier to chemical exposure (e.g. fume hoods)
- Signs and symptoms associated with hazardous chemical exposure
- Waste management and disposal

** Note: Respirators use (in lieu of engineering controls) requires additional training per 29 CFR 1910.134(c)(2)] shall be instituted.**

18.1 REFERENCE MATERIALS

1. Reference materials on chemicals- hazards and safe handling methods include container labels and MSDSs. Hard copies of MSDSs shall be maintained in the Chemistry Stockroom, Temple 403. Faculty may also be a resource for reference materials.
2. Contact the Environmental Management Department for reference materials related to hazardous waste management and disposal.

Appendix A: OSHA Laboratory Standard

29 CFR 1910.1450—Occupational Exposure to Hazardous Chemicals in Laboratories

- a. Scope and application.
 1. This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.
 2. Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:
 - i. For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.
 - ii. Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.
 - iii. Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.
 3. This section shall not apply to:
 - i. Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.
 - ii. Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:
 - A. Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and
 - B. Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.
 - b. Definitions—"Action level" means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee. "Carcinogen" (see "select carcinogen").

"Chemical Hygiene Officer" means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

"Chemical Hygiene Plan" means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section. "Combustible liquid" means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

"Compressed gas" means: (i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or (ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg. C) regardless of the pressure at 70 deg. F (21.1 deg. C); or (iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 deg. C) as determined by ASTM D-323-72.

"Designated area" means an area 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, such as a laboratory hood.

"Emergency" means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

"Employee" means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

"Explosive" means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

"Flammable" means a chemical that falls into one of the following categories:

- i. "Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
- ii. "Gas, flammable" means: (A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or (B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.
- iii. "Liquid, flammable" means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which makes up 99 percent or more of the total volume of the mixture.
- iv. "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

"Flashpoint" means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

- i. Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))-for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or
- ii. Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))—for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or
- iii. Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)). Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

"Hazardous chemical" means 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 systems, and agents which damage the lungs, skin, eyes, or mucous membranes. Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

"Laboratory" means 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" means 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-type hood" means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms. Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

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

- i. Chemical manipulations are carried out on a "laboratory scale;"
- ii. Multiple chemical procedures or chemicals are used;
- iii. The procedures involved are not part of a production process, nor in any way simulate a production process; and

- iv. "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

"Medical consultation" means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

"Organic peroxide" means an organic compound that contains the bivalent —O—O— structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by an organic radical.

"Oxidizer" means a chemical other than a blasting agent or explosive as defined in 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

"Physical hazard" means 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.

"Protective laboratory practices and equipment" means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

"Reproductive toxins" means chemicals which affect the reproductive chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

"Select carcinogen" means any substance which meets one of the following criteria:

- i. It is regulated by OSHA as a carcinogen; or
- ii. It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
- iii. It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or

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 a lifetime to dosages of less than 10 mg/m³; (B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or (C) After oral dosages of less than 50 mg/kg of body weight per day.

"Unstable (reactive)" means a chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature. "Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

- c. Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.
- d. Employee exposure determination
 1. Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).
 2. Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.
 3. Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.
 4. Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.
- e. Chemical hygiene plan-General. ([Appendix A](#) of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan.)
 1. Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:
 - i. Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and
 - ii. Capable of keeping exposures below the limits specified in paragraph (c) of this section.
 2. The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.
 3. The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection:
 - i. Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;
 - ii. Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;
 - iii. A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;
 - iv. Provisions for employee information and training as prescribed in paragraph (f) of this section;
 - v. The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;
 - vi. Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

- vii. Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and
- viii. Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:
 - A. Establishment of a designated area;
 - B. Use of containment devices such as fume hoods or glove boxes;
 - C. Procedures for safe removal of contaminated waste; and
 - D. Decontamination procedures.
- 4. The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.
- f. Employee information and training.
 - 1. The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.
 - 2. Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.
 - 3. Information. Employees shall be informed of:
 - i. The contents of this standard and its appendices which shall be made available to employees;
 - ii. the location and availability of the employer's Chemical Hygiene Plan;
 - iii. The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;
 - iv. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and
 - v. The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.
 - 4. Training.
 - i. Employee training shall include:
 - A. Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);
 - B. The physical and health hazards of chemicals in the work area; and
- g. Medical consultation and medical examinations.

1. The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:
 - i. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.
 - ii. Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
 - iii. Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.
2. All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.
3. Information provided to the physician. The employer shall provide the following information to the physician:
 - i. The identity of the hazardous chemical(s) to which the employee may have been exposed;
 - ii. A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and
 - iii. A description of the signs and symptoms of exposure that the employee is experiencing, if any.
4. Physician's written opinion.
 - i. For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:
 - A. Any recommendation for further medical follow-up;
 - B. The results of the medical examination and any associated tests;
 - C. 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
 - D. 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.
 - ii. The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.
- h. Hazard identification.
 1. With respect to labels and material safety data sheets:

- i. Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.
 - ii. Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.
2. The following provisions shall apply to chemical substances developed in the laboratory:
 - i. If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.
 - ii. If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.
 - iii. If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.120) including the requirements for preparation of material safety data sheets and labeling.
 - i. Use of respirators. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.
 - j. Record-keeping.
 1. The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.
 2. The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.20.
- k. Dates.
 1. Effective date. This section shall become effective May 1, 1990.
 2. Start-up dates.
 - i. Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.
 - ii. Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.
1. Appendices. The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation

APPENDIX B: STANDARD PLAN TERMS & DEFINITIONS

Action Level A concentration designated in 29 CFR 1910.1450 for a specific substance, calculated as an 8-hour time-weighted average, which initiates certain required activities (Appendix D).

Chemical Hygiene Officer An employee who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan.

Chemical Hygiene Plan A written program developed and implemented which sets forth procedures, equipment, person protective equipment (PPE), and work practices that are capable of protecting employees from health hazards and physical hazards presented by hazardous chemicals used in the laboratory. This plan shall be reviewed annually. If applicable, necessary updates will be incorporated within the annual time frame.

Designated Area An area that may be used for work with select carcinogens, reproductive toxins or substances that 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 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, and neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Laboratory A facility where the laboratory use of hazardous chemicals may occur. It is a workplace where relatively small quantities of hazardous chemicals are used on a nonproduction basis.

Laboratory Employee An individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his/her assignments whether full-time or part-time employees.

Laboratory Scale Work 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 Use of Hazardous Chemicals Handling or use of such chemicals in which the following conditions are met:

1. Chemical manipulations are carried out on a laboratory scale.
2. Multiple chemical procedures or chemicals are used.
3. The procedures involved are not part of a production process nor in any way simulate a production process.
4. Protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Reproductive Toxins Chemicals that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogens).

Select Carcinogen Any substance that 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 latest edition of the National Toxicology Program.
3. It is listed under Group 1 (carcinogenic to humans) by the International Agency for Research on Cancer Monographs (IARC).
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 a lifetime to dosages of less than 10 mg/m³;
 - 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.

APPENDIX C: INCOMPATIBLE CHEMICAL TABLES
TABLE 1—PARTIAL LISTING OF INCOMPATIBLE CHEMICALS (REACTIVE HAZARDS)

Acetic Acid	Chromic Acid, Nitric Acid, peroxides, and permanganates
Acetic Anhydride	Hydroxyl-containing compounds, Ethylene Glycol, Perchloric Acid
Acetone	Concentrated acids such as Nitric Acid and Sulfuric Acid
Acetylene	Chlorine, Bromine, Copper, Silver, Fluorine, Mercury
Alkali metals-Na,K,Li,Mg,Ca	Carbon Dioxide, chlorinated hydrocarbons
Ammonia (anhydrous)	Mercury, Chlorine, Calcium Hypochlorite, Iodine, Bromine, Hydrogen Fluoride
Aniline	Nitric Acid, Hydrogen Peroxide
Bromine	Ammonia, Acetylene, Butadiene, Butane, Sodium Carbide, Benzene, turpentine
Calcium Oxide	Water
Carbon, activated	Calcium Hypochloride, other oxidants
Chlorates	Ammonium salts, acids, metal powders, Sulfur, finely divided organics
Chromic Acid	Acetic Acid, Naphthalene, Camphor, Glycerol, turpentine, alcohols
Chlorine Dioxide	Ammonia, Methane, Phosphine, Hydrogen Sulfide
Copper	Acetylene, Hydrogen Peroxide
Fluorine	<i>Isolate from everything</i>
Hydrazine	Hydrogen Peroxide, Nitric Acid, any other oxidant
Hydrocarbons (e.g. Toluene)	Fluorine, Chlorine, Bromine, Chromic Acid, peroxides
Hydrocyanic Acid	Nitric Acid, alkalies
Hydrofluoric Acid	Ammonia, aqueous or anhydrous
Hydrogen Peroxide	Copper, Chromium, Iron, other metals or their salts, organic solvents
Hydrogen Sulfide	Fuming Nitric Acid, oxidizing gases
Iodine	Acetylene, Ammonia (anhydrous or aqueous)
Mercury	Acetylene, Ammonia
Nitric Acid	Acetic Acid, Acetone, Aniline, Chromic Acid, organic solvents, Hydrogen Sulfide
Nitroparaffins	Inorganic bases, amines
Oxalic Acid	Silver, Mercury
Oxygen	Oils, grease, Hydrogen, flammable liquids, solids, or gases
Perchloric Acid	Acetic Anhydride, Bismuth and alloys, paper, wood, grease, oils, alcohols
Peroxides, organic	Acids (organic and mineral), should store cold
Phosphorus, white	Air, Oxygen
Potassium Chlorate	Acids, (see chlorates)
Potassium Perchlorate	Acids, (see perchloric acid)
Potassium Permanganate	Glycerol, Ethylene Glycol, Benzaldehyde, Sulfuric Acid
Silver	Acetylene, Oxalic Acid, Tartaric Acid, Ammonium compounds
Sodium	(see alkali metals)
Sodium Nitrite	Ethanol, Methanol, Acetic Acid, Acetic Anhydride, Carbon Disulfide, Glycerol
Sulfuric Acid	Chlorates, perchlorates, permanganates

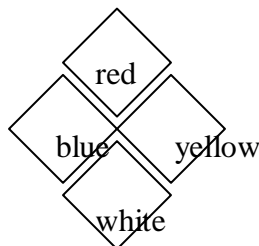
TABLE 2—PARTIAL LIST OF INCOMPATIBLE CHEMICALS (TOXIC HAZARDS)

Arsenical materials	Any reducing agent	Arsine
Azides	Acids	Hydrogen Azide
Cyanides	Acids	Hydrogen Cyanide
Hypochlorites	Acids	Chlorine
Nitrates	Sulfuric Acid	Nitrogen Dioxide
Nitric Acid	Copper, brass, heavy metals	Nitrogen Dioxide (nitrous fumes)
Nitrites	Acids	Nitrous fumes
Phosphorus	Caustic alkalies or reducing agents	Phosphine
Selenides	Reducing agents	Hydrogen Selenide
Sulfides	Acids	Hydrogen Sulfide
Tellurides	Reducing agents	Hydrogen Telluride

Tables reprinted from "Hazards in the Chemical Laboratory"

Appendix D. National Fire Protection Association (NFPA) Hazard Diamond

This labeling system uses 4 diamonds of different colors to denote various types of hazards. Within each colored diamond is a number that indicates the level of hazard for the material.



Health (Blue Diamond)

- 0 *No health hazard when used with responsible care.*
- 1 *Slightly toxic material.* May cause irritation, but only minor residual injury even without treatment.
- 2 Moderately toxic material. Intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.
- 3 *Seriously toxic material.* Short term exposure could cause serious temporary or residual injury even though prompt medical treatment is given. Includes known or suspect small animal carcinogens, mutagens or teratogens.
- 4 *Highly toxic material.* Very limited exposure could cause death or major injury even though prompt medical treatment is given. Includes known or suspect human carcinogens, mutagens or teratogens.

Flammability (Red Diamond)

- 0 Materials which will not burn.
- 1 *Slightly combustible.* Material which requires considerable preheating before ignition can occur. This rating includes most ordinary combustible materials.
- 2 *Combustible.* Materials which must be moderately heated before ignition can occur. Includes liquids having a flash point above 100 degrees F, and solids which readily give off flammable vapors.
- 3 *Flammable.* Liquids and solids that can be ignited under almost all ambient temperature conditions. Includes liquids with a flash point below 73 degrees F and a boiling point above 100 degrees F, solid materials which form coarse dusts that burn rapidly without becoming explosive, materials which burn rapidly by reason of self-contained oxygen (i.e. organic peroxides), and materials which ignite spontaneously when exposed to air.
- 4 *Extremely flammable.* Materials which will rapidly vaporize at normal pressure and temperature and will burn readily. Includes gases, cryogenic materials, any liquid or gaseous material having

a flash point below 73 degrees F and a boiling point below 100 degrees F, and materials which can form explosive mixtures with air.

Reactivity (Yellow Diamond)

- 0 Materials which are normally stable, even under fire conditions, and which are not reactive with water.
- 1 Materials which are normally stable, but which can become unstable at elevated temperatures and pressures, or which may react with water with some release of energy, but not violently.
- 2 Materials which in themselves are normally unstable and readily undergo violent chemical change, but do not detonate. It includes materials which may react violently with water or which may form potentially explosive mixtures with water.
- 3 Materials which in themselves are capable of detonation but which require a strong initiating source, or which must be heated first. This rating includes materials which are shock sensitive at elevated temperatures, and which react explosively with water without requiring heat.
- 4 Materials which in themselves are readily capable of detonation or explosive decomposition at normal temperatures and pressures. Includes materials which are shock sensitive at normal temperatures and pressures.

Special Notice (White Diamond)

- OX** Denotes materials that are oxidizing agents. These compounds give up oxygen easily, remove hydrogen from other compounds or attract negative electrons.
- W** Denotes materials that are water reactive. These compounds undergo rapid energy releases on contact with water.