Occupational Health Laboratory
Laboratory Information Management System
Chemical Hygiene Plan

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1. Scope

1.1 LESS Statement of Responsibility

It is the responsibility of LESS, as an employer, to take every reasonable precaution to provide a work environment that is free from recognizable hazards for its employees in accordance with the "General Duty" clause of the Michigan Occupational Safety and Health Act, Section 11 (a).

Furthermore, LESS is required by the MIOSHA "Hazardous Work in Laboratories" - ***Part 431*** standard, ***Appendix A***, to ensure that the necessary work practices, procedures and policies are implemented to protect all employees working in MWHTSD leased facilities from hazardous chemicals in the work place. Traditionally, MIOSHA health standards have been established to help protect industrial and manufacturing workers who may be exposed to significant quantities of, usually, a few hazardous chemicals over a working lifetime. In laboratories the use of hazardous chemicals is generally limited to small quantities used on a short-term basis and in operations where the chemicals and procedures change frequently. The laboratory standard demonstrates that MIOSHA has recognized the need for a standard, which focuses on the unique nature of laboratory work.

The laboratory standard requires the development and implementation of a formal, written, and employee accessible program referred to as a chemical hygiene plan (CHP). This plan must be capable of protecting employees from health hazards associated with hazardous chemicals used in the laboratory. Additionally, the laboratory standard supercedes the provisions of all other MIOSHA/OSHA health standards, except for: the obligation to maintain employee exposures at or below the permissible exposure limits (sub part 2 of 1910.1200), prohibition of skin and eye contact where specified by any OSHA/MIOSHA standard and in other instances where the scope of the hazard are not adequately addressed by this standard.

1.2 Scope and Application

This document serves as the written guide for LESS compliance to the Laboratory Standard and the chemical hygiene plan (CHP) requirements contained therein. All units of MWHTSD engaged in the laboratory use (as defined by this document) of hazardous chemicals are required to comply with this document.

The primary objective of this document is to provide a general guide for handling hazardous chemicals in the LESS laboratory. The CHP establishes the basic safety principles for laboratory procedures, equipment, and work practices that are capable of protecting employees from the physical and health hazards of hazardous chemicals in laboratory.

This document is intended to only highlight those safety measures necessary for achieving a safe and healthy work environment. Where the scope of hazards is not adequately addressed by this document, specific standard operating procedures (SOPs) must be developed by the LESS staff and approved by the laboratory supervisor. The CHP does not, however, apply to:

1. Work involving chemicals that do not meet the conditions of the definition of laboratory use of hazardous chemicals. In such cases, the employees shall comply with all relevant specific substance standards even if such use occurs in a laboratory type setting.

2. Work involving the laboratory use of hazardous chemicals that does not have the potential for employee exposure.

1.3 Definitions of Hazardous Chemicals

A hazardous chemical is defined by MIOSHA as any chemical, chemical compound, or mixture of compounds which is a physical and/or health hazard.

A chemical is a physical hazard by MIOSHA definition if there is scientifically valid evidence that it is:

- A flammable or combustible liquid
- A compressed gas
- An organic peroxide
- An explosive
- An oxidizer
- A pyrophoric
- An unstable material (reactive)
- A water reactive material.

A chemical is a health hazard by MIOSHA definition if 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. Included are:

- Agents, which damage the lungs, skin, eye or mucous membranes
- Allergens
- Carcinogens
- Corrosives
- Embryotoxicants
- Hematopoietic systems agent (blood)
- Hepatoxins (liver)
- Irritants
- Nephrotoxins (kidneys)
- Neurotoxins (nervous system)
- Reproductive toxicants
- Sensitizers
- Toxic or highly toxic agents.

Particularly hazardous substances by MIOSHA definition are select carcinogens, reproductive toxicants and chemicals with a high degree of acute and chronic toxicity.

Select carcinogens are chemicals listed by MIOSHA as carcinogens, by The National Toxicology Program (NTP) as "Known to be carcinogens" and by the International Agency for Research on Cancer (IARC) as Group I carcinogens. Also included are chemicals listed in either Group A or 2B by IARC or under the category "reasonably anticipated to be

carcinogens" by NTP that cause statistically significant turnover incidence in experimental animals in accordance with any of the following:

1. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less then $10mg/m^3$.

2. After repeated skin application of less than 300 mg/kg of body weight per week.

3. After oral dosages of less than 50 mg/kg of body weight per day.

4. MIOSHA; IARC Group 1,2A and 2B as well as the NTP carcinogens are listed in Appendix B.

Reproductive toxicants are defined by MIOSHA as any chemical, which affects the reproductive capabilities of males or females, including chromosomal damage (mutagenesis) and effects on fetuses (teratogenesis). Additional information should be listed on the SDS.

Chemicals with a high degree of acute and chronic toxicity are not defined in the Laboratory Standard. The MIOSHA Hazard Communication definition will be used for ***this*** CHP. Chemicals with a high degree of acute toxicity are chemicals that have a median lethal dose (LD 50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each. The LD50 is the dose at which a lethal response is observed in 50% of the test population.

The following sources have established lists of hazardous chemicals based on substantiated tests:

1. OSHA, 29 CFR 1910.1200 subpart z, toxic and hazardous substances and appendices A and B of OSHA 29 CFR 1910.1200, which are referenced in MIOSHA R325.70101 (2).
2. American Conference of Governmental Industrial Hygienists (ACGIH), "Threshold limit values for chemical substances and physical agents in the work environment".

The hazard(s) of a chemical may also be listed on its container label. Additionally, the **Safety data sheet (SDS)** will list the specific hazards.

2. Responsibilities

Responsibilities for chemical hygiene rest at all levels within the Department of Licensing and Regulatory Affairs.

2.1 The Director of LARA, has the ultimate responsibility for chemical hygiene within LARA and must, with other department administrators provide continuing support for departmental chemical hygiene.

2.2 The Director of the MIOSHA Wage Hour and Technical Services Division (MWHTSD) will serve as the liaison between LARA administration and the Occupational Health Laboratory (OHL).

2.3 The Program Manager of OHL, has overall responsibility for chemical hygiene in the laboratory including the responsibility to:

2.3.1 Ensure the analysts understand and follow the chemical hygiene rules, that personal protective equipment (PPE) is available and in working order, and that appropriate training had been provided;
2.3.2 Provide regular, formal chemical hygiene and housekeeping inspections of the facilities and emergency equipment;
2.3.3 Know the current legal requirements concerning regulated substances;
2.3.4 Determine the required levels of protective apparel and equipment;
2.3.5 Ensure that facilities and training for the use of any material ordered are adequate.

2.4 The Chemical Hygiene Officer (CHO) is responsible for chemical hygiene within the LESS. CHO responsibilities include:

2.4.1 Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices;
2.4.2 Monitor procurement, use and disposal of chemicals used in the laboratory;
2.4.3 See that appropriate related audits are maintained;
2.4.4 Help the laboratory supervisor develop precautions and adequate facilities;
2.4.5 Know the current legal requirements concerning regulated substances;
2.4.6 Seek ways to improve the chemical hygiene program.

2.5 Every laboratory employee is responsible for:

2.5.1 Planning and conducting each operation in accordance with the departmental chemical hygiene plan;
2.5.2 Applying good personal chemical hygiene habits.

2.6 Employee Rights

It is the employee's right to receive information about the known physical and health hazards of the hazardous chemical in their work areas and to receive adequate training to work safely with these substances. Employees have the right to work in a safe environment and it is their responsibility to inform the laboratory supervisor or CHO of any potential risks in the laboratory.

2.7 Availability

The Chemical Hygiene Plan must be readily available to employees and employee representatives. It must be available to any and all contractors performing work at the facility.

2.8 Annual Review

The CHP will be reviewed annually from its effective date by the CHO.

3. The Laboratory Facility

3.1 **Design**.
3.1.1 The laboratory shall have:
3.1.1.1 An appropriate general ventilation system with air intakes and exhausts located to avoid intake of contaminated air;
3.1.1.2 An adequate, well-ventilated stockroom;
3.1.1.3 Laboratory fume hoods and sinks;

3.1.1.4 the safety equipment including eyewash fountains and drench shower;
3.1.1.5 Arrangements for waste disposal.

3.2 **Maintenance**.

3.2.1 Inspect chemical hygiene related equipment, such as hoods and spill kits, quarterly during the safety inspection and repair or modify if inadequate.

3.3 **Usage**.

3.3.1 The work conducted and its scale must be appropriate to the physical facilities available and to the quality of ventilation.

3.4 **Ventilation**.

3.4.1 General laboratory ventilation. This system should provide a source of air for breathing and for input to local ventilation devices. It should not be relied on for protection from toxic substances released into the laboratory. The general lab ventilation system should prevent an increase in air concentrations of toxic substances during the working day by continually replacing the laboratory air. The system should also direct airflow into the laboratory from non-laboratory areas.

3.4.2 Hoods. In a laboratory where lab staff spends most of their time working with chemicals, provide at least one hood for every two workers with at least 2.5 linear feet of working space per person. If a hood does not have a device to allow continuous monitoring of adequate hood performance, check the performance before each use and avoid working with substances of unknown toxicity. Evaluate hoods before initial use to ensure adequate face velocities, typically 80-120 lfm, and absence of excessive turbulence by smoke generation devices. Face velocities in excess of 125-150 lfm are recommended by some sources for work with chemicals of high toxicity (TLV<10 ppm). Keep storage of chemicals and apparatus in a hood to a minimum. Do not place chemicals or equipment in a hood where they will dramatically affect performance. If possible, design procedures to trap or scrub toxic materials that would be released to the hood and vented outside. Some materials may be sufficiently toxic that they should not be exhausted by a hood and into the air. Use HEPA filters to trap highly toxic particulates and activated charcoal filters trap highly toxic gases and vapors.

3.4.3 Other local ventilation devices. Provide canopy hoods, ventilated storage cabinets, snorkels, etc. as needed for prevention of chemical hygiene problems. Properly vent atomic absorption and fluorescence spectrophotometers. Have a separate exhaust duct for each canopy hood and snorkel.

3.4.4 Modifications. Make alterations of the ventilation system only if thorough testing indicates that worker protection from airborne substances will remain adequate.

3.4.5 Performance. Four to twelve air changes per hour is normally adequate if local exhausts such as hoods are used as the primary method of control.

3.4.6 Quality. General airflow should not be turbulent and should be relatively uniform throughout the laboratory with no high velocity or static areas. Airflow into and within the hood should not be excessively turbulent.

3.4.7 Evaluation. Evaluate ventilation upon installation before initial use, at least every six months, and reevaluate when a change in local ventilation devices is made.

4. General Operating Procedures

The general operating procedures described here specify minimum regulations and recommendations.

4.1. General Safety Principles

4.1.1. Examine the known hazards associated with the materials being used. Never assume all hazards have been identified. Carefully review the SDS before using an unfamiliar chemical. Determine the potential hazards and use appropriate safety precautions before beginning any new operation.

4.1.2. Be familiar with the location of all emergency equipment; fire alarms, fire extinguishers, eyewashes and shower stations and know the appropriate emergency response procedures.

4.1.3. Avoid disturbing or distracting other workers when they are working with, or near, hazardous chemicals.

4.1.4. Use equipment and hazardous chemicals only for their intended propose.

4.1.5. Always be alert to unsafe conditions and actions and call attention to them immediately so that corrective action can be taken as soon as possible.

4.1.6. Wear eye, face, and hand protection when appropriate.

4.1.7. Always inspect equipment for leaks, tears, and other damage before handling a hazardous chemical. This includes fume hoods, gloves, goggles, snorkels, etc.

4.1.8. Avoid tasting or smelling hazardous chemicals.

4.2. General Personal Hygiene Principles

4.2.1. Avoid direct contact with any hazardous chemical. Know the types of PPE available and use the proper type for each job.

4.2.2. Confine long hair and loose clothing, and always wear a shoe that fully covers the foot area.

4.2.3. Never mouth pipette any chemicals.

4.2.4. Use appropriate safety equipment whenever exposure to gases, vapors or aerosols is suspected and ensure exhaust facilities are functioning properly.

4.2.5. Wash thoroughly with soap and water after handling chemicals, before leaving the laboratory and before eating or drinking.

4.2.6. Contact lenses are prohibited in the laboratory unless approved in writing by the laboratory supervisor.

4.2.7. Replace personal protective equipment as appropriate.

4.2.8. Laboratory employees shall be familiar with the symptoms of exposure for the chemicals with which they work and the precautions necessary to prevent exposure.

4.3.Food and Drink in The Laboratory

4.3.1. There will be no food, drink, use of tobacco products, or application of cosmetics in any of the laboratory areas. There will be no storage, use or disposal of these consumables in any laboratory areas; this includes all refrigerators within the lab areas. No chemicals, samples or cold packs, used for keeping samples cold during shipment, may be stored in any refrigerator used for storing food. All refrigerators/freezers in the LESS facility must be clearly marked as to their acceptable contents.

4.4. Housekeeping

4.4.1. Safety follows from good housekeeping practices. Use the following guidelines to maintain an orderly laboratory:

4.4.2. Keep work areas clean and uncluttered with chemicals and equipment. Clean-up work areas upon completion of operation at the end of each workday, including floors.

4.4.3. Clean all spills immediately and thoroughly. Make use of spill kits as needed. Spill kits are located in room 109 under the bench with the temperature chart recorder on the South side of hood H1/H2 and in room 111 under the table near the door to room 110.

4.4.4. A separate waste receptacle must be designated for non-contaminated glass. All glass, even broken pieces, must be decontaminated prior to disposal in this receptacle.

4.4.5. Do not block exits, emergency equipment, phones, or controls or use hallways or stairways as storage areas. All passages must be two feet wide or wider.

4.4.6. Custodial staff should clean floors regularly.

4.5. Chemical Handling and Storage

The decision to use a hazardous chemical is a commitment to handle and use the chemical properly from initial receipt to disposal. See Section 5 for specific requirements for certain types of chemicals.

4.5.1. Information on proper handling, storage, and disposal of hazardous chemicals is available on the SDS. The employee should review the SDS of any chemical they do not regularly use.

4.5.2. Always order the minimum amount of a chemical that will be used in a reasonable amount of time. Excess chemicals become waste disposal problems; with some costing more to dispose of then they did to purchase.

4.5.3. Any chemical or container with a missing or defaced label should not be accepted.

4.5.4. Chemicals used in the laboratory must be appropriate for the laboratory's ventilation system. Radioactive, and biologically active materials, as well as perchloric acid are prohibited.

4.5.5. Chemicals should not be stored on high shelves and large bottles (2.5L & 4L) should not be stored more than three feet from floor level.

4.5.6. Chemicals should be segregated by compatibility.

4.5.7. Storage of chemicals at the lab bench or other work areas shall be kept at a minimum.

4.5.8. Any chemical mixture shall be assumed to be as toxic as its most toxic component.

4.5.9. Substances of unknown toxicity shall be assumed to be toxic

4.5.10. Opened vessels containing highly toxic chemicals must be stored in an unbreakable secondary container.

4.5.11. Avoid exposing chemicals to heat or direct sunlight.

4.5.12. The Chemical Hygiene Officer or Laboratory Supervisor will designate staff to perform an biennial inventory verification of all chemicals. The inventory will be kept as an electronic file.

4.5.13. The Laboratory Supervisor will designate one staff member to be in charge of the chemical inventory. This person will be responsible for removing expired chemicals, or provide a list to the CHO containing chemicals that need to be recertified. See Chemical Inventory SOP, OHL2002S002.

4.5.14. All expired or unneeded chemicals must be disposed of properly.

4.5.15. At present LESS uses ERG (Environmental Recycling Group) for handling its chemical waste.

4.6. Ventilation

4.6.1. General (Dilution) ventilation.

4.6.1.1. This system should provide a source of air for breathing and for input to local ventilation devices. General ventilation systems are not recommended for the use of hazardous chemicals. To determine ventilation requirements, assess the SDS. Some SDS terminology, as listed below, may indicate a need for special ventilation consideration beyond general dilution ventilation:

- ♦ Use with adequate ventilation
- ♦ Use in a fume hood
- ♦ Avoid vapor inhalation
- ♦ Provide local exhaust.

4.6.2. Local Exhaust- Fume Hoods

4.6.2.1. Fume hoods are a ventilated, enclosed workspace intended to capture, contain and exhaust harmful or dangerous fumes, vapors and particle matter generated by procedures conducted with hazardous chemicals. All hoods must be evaluated prior to the initial use to ensure adequate face velocities, typically 80-120 lfm, and the absence of excessive turbulence. These tests must be performed at least once every six months. The face velocity of air being drawn into the hood at the working sash height is measured quantitatively in linear feet per minute (lfm). One measurement is taken per square foot of face space (at a minimum). This test can be performed by a licensed outside contractor, using their own documented procedures. Hoods must have an average face velocity of 80-120 lfm, depending on their design, with 100 lfm being the ideal average face velocity. The turbulence of the air is measured qualitatively by releasing smoke from a smoke device. The smoke must be captured by the hood with a minimum of turbulence.

4.6.2.2. If the hood does not pass the face velocity test and/or has excessive turbulence, it will be posted as "FAILED" by the inspector, and may not be used until it is repaired and passes both tests.

4.6.2.3. If the hood does pass, the inspector will post the date of inspection and will mark the hood to indicate proper sash position for optimum hood performance. In general, the sash height should be set at a level where the operator is shielded to some degree from any explosions or violent reactions that could occur and, where optimum airflow dynamics are achieved. If a fume hood does not have any markings regarding sash height or inspection dates, please contact the lab supervisor or CHO to arrange an inspection.

4.7. Environmental Monitoring.

LESS currently monitors temperature and humidity trends as well as carbon monoxide levels. Other monitoring may be appropriate when testing or redesigning hoods or other ventilation devices or when highly toxic substances are stored or used regularly. Check with CHO, or Laboratory Supervisor about any specific environmental monitoring concerns.

4.8. Housekeeping, Maintenance, and Inspections

4.8.1. Cleaning.

4.8.1.1. Custodial staff should clean floors regularly.

4.8.1.2. Analysts are responsible for keeping their work areas tidy. Work spaces should be free of excess clutter (dirty glassware, old papers, broken/unused parts, etc.) and work surfaces should be kept clean and free of dust and debris.

4.8.2. Inspections and Maintenance.

4.8.2.1. Designated parties, consisting of the CHO and another staff volunteer, shall conduct quarterly formal housekeeping and chemical hygiene inspections based on form OHL2000F014. The Chemical Hygiene Officer shall produce a written report of findings, including deficiencies and recommendations, and distribute to LESS staff. Each staff member must respond promptly to correct any deficiencies noted in their own work area(s).

4.8.2.2. All laboratory staff should conduct informal inspections continually and report related concerns to the CHO or lab supervisor.

4.8.2.3. If respirators and other safety equipment are provided for routine use, supervisory staff should regularly inspect the equipment.

4.8.3. Passageways.

4.8.3.1. Do not store items in hallways or passageways. Never block access to exits, emergency equipment, or utility controls. The minimum width for any passage is two feet. Any width narrower than two feet is considered a blocked passage.

4.8.3.2. Chemical supplies must be moved to the room 109 immediately upon receipt. At no point should chemical supplies be left unattended in any area outside of the laboratory, including the entryway and office locations.

4.9. Medical Program

4.9.1. Compliance with regulations.

4.9.1.1. Establish regular medical surveillance to the extent required by regulators. LESS does not require regular monitoring at this time.

4.9.2. Routine surveillance.

4.9.2.1. Individually consult with MWHTSD administration about whether regular medical surveillance is desirable due to regular and frequent handling of toxicologically significant quantities of chemicals.

4.9.3. First aid.

4.9.3.1. Contact the emergency response personnel in the laboratory if first aid or emergency medical treatment is required during working hours. The initial responsibility for first aid rests with the first person (s) at the scene, who should act quickly in a calm and reassuring manner. See Personal Injury Accident Response Flow Chart located near each telephone. Immediately summon medical help by calling ***9-911*** and inform a supervisor. *Note that the LESS intercom, 2-3224, may be used to call for help.* Explicitly report the suspected types of injury of illness and type of assistance being requested. Do not move an injured person except to prevent further injury. One or more workers should have first aid and cardiopulmonary resuscitation (CPR) training in each work area as provided by the Michigan Civil Service course titled Emergency Medical Techniques. Currently OHL has three employees that have received appropriate training: Dave Isenga, Dave Almanza and Adam Mittino.

4.10. Protective Apparel and Equipment

4.10.1. Prescription safety glasses are available for all permanent laboratory staff. Visitor safety glasses are provided for all visitors to laboratory areas. The glasses are discarded after use.

4.10.2. Laboratory gowns or coats are provided to all laboratory staff.

4.10.3. Disposable gloves, goggles, face shields, aprons, and other protective apparel or equipment are provided as necessary for particular laboratory operations.

4.10.4. Drench-type safety showers are available in rooms 111 and 109. There are showers in the men's and women's bathrooms that may be used after the initial exposure has been neutralized. Tyvek suits are available from ICM if necessary.

4.10.5. Eyewash fountains are available in the following locations: two in room 111; one in room 118; and three in rooms 109, 116 and 115.

4.10.6. Fire extinguishers are located in room 109 (three), room 111 (two), and one each in rooms 108, 119, 113, 115, 116, the entrance foyer, and the hallway outside room 107.

4.10.7. Alarm boxes for the fire alarm system are located in room 116 by the door to DOS and inside the entrance foyer, and by the side exit door in room 109.

4.10.8. Power/gas shutoffs are located at the entrance of rooms 111 and 109, room 108 and outside entrance on west wall of room 109. There is also a shutoff in room 109 outside the entrance to room 111.

4.11. Records

4.11.1. Accident records and near miss reports are prepared by the laboratory supervisor or designee and are retained in her office or designated area, as well as forwarding a copy to the division director. MIOSHA's "Supervisor's Accident/Incident Analysis," "Near-Miss Accident/Exposure Report" and "Employee Report Of Hazard(s)" are located in the "Safety And Health Management System" folder located at *S:\Public\Transfer\New Employee Orientation*. Note: a "near miss" is an incident which does not lead to lost work time and it may not be an actual accident but rather it can be a "close call." An accident that results in lost work time requires an accident report.

4.11.2. The Chemical Hygiene Plan is maintained in the LESS office and online at *S:\bsrohtss\Manuals\Chemical Hygiene Plan*.

4.11.3. The chemical inventory is maintained as a computer file.

4.11.4. Medical records are retained by the Division of Human Resources (LARA).

4.12. Signs and Labels. Post signs and labels of the following type:

4.12.1. Phone numbers of emergency personnel and all emergency services are to be posted on or near each telephone.

4.12.2. Label all chemical containers, including waste receptacles, in order that their contents may be readily identified.

4.12.3. Clearly note the location of safety showers, eyewash stations, other safety and first aid equipment, and exits.

4.12.4. Restrict the storage and consumption of food and beverages to non-laboratory areas presenting no chemical exposure risk.

4.12.5. Post warning labels in other areas as appropriate addressing specific hazards associated with the work space, i.e. Safety Glasses Required, Flammable Storage, etc.

4.13. Spills and Accidents

4.13.1. Follow the Department's emergency plans as related to ventilation failure, evacuation, medical care, reporting, and drills. See Appendix K.

4.13.2. Ensure that the alarm system is able to reach all people in all parts of the facility including potential isolation areas such as cold rooms and restrooms.

4.13.3. Try to prevent spills through proper storage of chemicals, use of standard operating procedures, monitoring and inspection of storage areas, and training of laboratory personnel.

4.13.4. If a spill occurs, evacuate the area and notify supervisory and plant protection personnel if the health or safety of you or your co-workers may be threatened. Minor spills that do not impose a threat should be contained and cleaned-up using appropriate safety techniques. Only trained and specially equipped personnel should attempt any significant clean-up operation See Section 4.14.

4.13.5. Report all spills to your supervisor and CHO, who will decide if the Eaton-Barry County Health Department, the Michigan Department of Natural Resources, or the U. S. Environmental Protection Agency must be informed.

4.13.6. Carefully analyze all accidents and near accidents. Distribute the results so all who may benefit have an opportunity to consider the incident.

4.13.7. Biohazard Spills: Refer to Appendix J for procedures

4.14. Basic Steps for Emergency and Spill Response:

Release of hazardous substances that pose a significant and immediate threat to health and safety require an emergency response regardless of the circumstances surrounding the release or other mitigating factors. The following definitions designate an **emergency situation:**

- The situation is unclear to the person causing or discovering the spill;
- The release requires evacuation of persons;
- The release involves or poses a threat of :
    - Fire, suspected fire, explosion or other imminent danger**,**
    - Conditions that are Immediately Dangerous to Life and Health (IDLH),
    - Exposure to toxic substances exceeding MIOSHA thresholds.
- The person(s) in the work area are uncertain that they can handle the severity of the hazard with the personal protective equipment (PPE) and response equipment that has been provided.

Conversely, releases that do not pose significant safety or health hazards to person(s) in the immediate vicinity or to the person(s) cleaning the release, or do not have the potential to become emergencies within a short time frame are not emergency situations. The following conditions describe **non-emergency situation:**

- The person(s) present when the release occurs or is discovered are aware of chemical hazards and able to make informed decisions regarding potential exposures as they relate to MIOHSA limits.
- The release can be appropriately cleaned up by the lab personnel using authorized (certified) spill kits.

  The materials are limited in quantity, exposure potential, or toxicity and present minor safety or health hazards to persons in the immediate work area or those assigned to clean-up activity.

4.14.1. **Emergency Situation – Fire**

The following steps are basic protocol for handling a fire or fire-related situation in the laboratory:

- Pull the fire alarm.
- Call3-0190 from a safe location.
- Notify the unit emergency coordinator.
- Evacuate

4.14.2. **Emergency Situation – Spill**

If the spill is of high toxicity or flammability or you are unsure how to proceed or is more than one liter; execute the following:

- Call 3-0190
- Evacuate the spill area and close doors to the room where the spill occurred.
- Isolate the spill area and close doors to the room where the spill occurred.
- Remove ignition sources and shut down equipment
- Establish exhaust ventilation to the outside of the building only.
- Turn on exhaust equipment.

Evacuation of the building is mandatory if chemicals or contaminants could enter the air circulation system of a building.

4.14.3. **Attending to victims of a body splash:**

- Remove person(s) from spill area to fresh air only if this action does not present additional danger to the rescuers or victim.
- Proceed to the nearest safety shower outside of the spill location and drench victim while removing contaminated clothing.
- Flood affected area(s) with cold water for at least 15 minutes – or longer if pain persists.
- Wash skin with mild soap and water – do not use neutralizing chemicals, creams, lotions or salves.
- Contact emergency response personnel with the identity of all chemicals involved.

4.14.4. **Attending to victims of an eye splash:**

- Remove victim(s) from spill area to fresh air only if this action does not present additional danger to the rescuers or victim.
- Lead the victim(s) immediately to the nearest emergency eye wash station outside of the spill location.
- Hold eyelids open.
- Flush eyes for at least 15 minutes or longer if pain persists.
- Contact emergency response personnel with the identity of all chemicals involved.

4.14.5. **Mercury Spills**

For very small spills, less than 1cc, such as a broken thermometer, use a trapped vacuum line attached to a tapered glass tube, similar to a medicine dropper, to pick up mercury droplets.

- Do not use a domestic or commercial vacuum cleaner.
- Cover small droplets in accessible areas with one of the following:

- Sodium polysulfide solution
- Powered sulfur
- Silver metal compounds
- Dry ice to freeze the mercury droplets

- Place residue in container for hazardous waste collection.

4.14.6. **Spill Kits**

Ready access to a chemical spill kit is required in laboratories that work with hazardous chemicals. Minimally, such a kit should contain:

- Splash resistant goggles
- Chemical resistant gloves
- Plastic bags
- Multi-chemical sorbent (enough for 2 gallon spill)
- Scooper

Some sorbents are chemically specific. The best sorbents are those, which can be used to clean-up all types of chemicals spills. Check absorbents in spill kits for their absorbency range.

Each laboratory's spill kit should be kept in a readily accessible location and each employee should be trained on how to use the spill kit. In room 109 the spill kit is located under the bench near the South end of hoods H1 and H2 in a large yellow tub and in room 111 the spill kit is located under the table with the telephone near entry 110 at the South end. In addition, both locations have a small bucket of universal sorbent material.

4.14.7. **Non-Emergency Situation – Spill**

If the spill is less than one liter and the chemical involved is of low toxicity and a low flammable hazard, handle it in the following manner:

- Locate the spill kit.
- Choose the proper protective equipment:
  - Always wear gloves and protective eye wear
  - Use additional protective equipment such as an apron, coveralls, or boots
- Confine or contain the spill.

4.14.8. **For non-reactive spills:**

- Cover liquid spills with spill kit absorbent and scoop into an appropriate disposal bag.
- Sweep solid materials into a dustpan and place in a sealed container.
- Dispose of waste as normal trash as long as substance is non-volatile, non-hazardous.

4.14.9. **For reactive or potentially reactive spills:**

- Cover liquid spill with spill kit absorbent and scoop into an appropriate disposal container.
- Wet mop dry substances to avoid spreading hazardous dust, provided it is non-water reactive.

- If spilled chemical is a volatile solvent, transfer disposal bag to a hood for evaporation of solvent.

4.14.10. **Power outages.** If emergency lighting and fire alarms **Are Not** operable, evacuate the building after the following steps have been taken:

- Place lids on all open containers of volatile chemicals
- Lower the sash on chemical fume hoods
- Shut down all equipment (leave cooling water and purge gases on as necessary)
- Turn off ignition sources
- Secure or isolate reactions that are underway (boiling liquid on a hot plate, distillations)
- Close fire doors
- Take your books, coats, purse/wallet, keys, etc.
- Lock outside door to lab

In anticipation of possible power outages, do the following:

- Have a flashlight conveniently located or other emergency lighting
- Make sure that all emergency contact numbers on the door are accurate and updated.

4.15 Information and Training Program

4.15.1 **Aim**

The goal of the information and training program is to assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs. Use form OHL2000F011, "New-hire Laboratory Analyst Training Plan Progress Report," for new employees.

4.15.2 **Emergency and Personal Protection Training**

Train every laboratory worker in the location and proper use of suitable protective apparel and equipment. Encourage staff to take available appropriate training which may be provided by the Department or the Civil Service course on Emergency Medical Techniques.

4.15.3 **Frequency**

Staff training and education is an on-going activity that is discussed at routine LESS staff and management meetings. Formal training goals are established annually for each individual.

4.15.4 **Literature/Consultation**

Staff routinely receive routed material related to chemical hygiene. They are encouraged to consult with MWHTSD or CET industrial hygienists about related concerns.

4.16 Waste Disposal Program

4.16.1 Aim

The goal of the LARA waste disposal program is to assure that disposal of waste laboratory chemicals results in minimal harm to people and the environment.

4.16.2 Content

4.16.2.1 Collection

Chemical wastes are collected in appropriate containers as they are generated with care taken to assure that components are compatible prior to mixing (i.e. non-reactive) – see appendix C as well as the following paragraphs on chemical segregation and storage. Unused samples are kept in their original containers, as are neat stocks which have expired or are no longer needed.

4.16.2.2 Segregation

4.16.2.2.1 Chemical wastes should be segregated based upon the following standard practices for chemical compatibility:

- Separate oxidizing and reducing agents
- Separate acids and bases
- Separate metals and organics
- Separate asbestos containing substances
- Separate acids and organics
- Separate chlorinated organics from non-chlorinated
- Separate cyanide containing wastes form other wastes
- Separate carbon disulfide and acetonitrile solvent wastes

4.16.2.2.2 Waste segregation categories in OHL include:

- Acids – metals containing and non-metals
- Bases – metals containing and non-metals
- Organics – halogenated, non-halogenated
- Vials and solid waste – autosampler vials, neat stock vials, contaminated towels, etc.

4.16.2.3 Storage

In general follow the segregation outline above. Store liquid wastes in glass bottles. Organics must be stored in amber or opaque glass. Solid and autosampler wastes are stored in steel cans or plastic containers. Waste that generates a strong odor should be stored in a separate container with activated charcoal. Do not store carbon disulfide wastes in containers greater than one liter. Do not mix waste containing potentially reactive chemicals, for example, carbon disulfide and amines in a waste container or nitric acid and organic solvents. Wastes are to be stored in the following locations:

- Acid/metal wastes are stored in the cabinets under the hoods in room 111.
- Non-DEQ asbestos waste is stored in a large garbage bag under the sink in room 111. DEQ asbestos samples are saved in a box and returned to DEQ.
- Organics are stored in cabinet C5 in room 109.
- Temporary storage of organic and cyanide waste in the cabinets under the hoods in room 109 is permissible.

4.16.2.4 Transportation

Waste is transported away from the OHL to the designated disposal site via a certified waste hauler. When moving wastes within the OHL,

secondary containment should be used for large vessels or highly toxic chemicals. Small vials and bottles may be carried by hand. Wastes that are heavy or otherwise difficult to handle should be transported via cart.

4.16.3 **Discarding Chemical Stocks**

Categorize and properly dispose of unlabeled containers of chemicals. Check for proper labeling during chemical hygiene inspections. Make additional checks before a departing laboratory worker terminates employment concerning chemicals for which he or she had responsibility.

4.16.4 **Frequency of Disposal**

Periodically remove laboratory waste to a ventilated storage area. Keep like materials together such as chlorinated hydrocarbons or acid waste. Prior to the scheduled waste pick-up dates by a licensed waste hauler, make a special check for additional chemicals that should be disposed of. Chemical waste pick up should be scheduled twice a year or more frequently as needed.

4.16.5 **Method of Disposal**

Incineration in an environmentally acceptable manner is a practical disposal method for combustible laboratory waste.

- Do not dispose of potentially toxic or reactive chemicals down the drain.
- Do not use hoods for disposal of volatile chemicals.
- When possible, use disposal by recycling or chemical decontamination.

5. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan requires that all laboratory workers know and follow its rules and procedures. In addition to the procedures of the subprograms mentioned above, these include the rules listed below.

5.1 **General Rules.** The following rules apply broadly to all laboratory work with chemicals.

5.1.1 Accidents and spills –

- Eye Contact: Promptly flush eye with water for a prolonged period (15 minutes) and seek medical attention.
- Ingestion: Encourage the victim to drink large amounts of water. Antidotes vary with different chemicals.
- Skin Contact: Promptly flush the affected area with water and remove any contaminated clothing. If symptoms persist after washing, seek medical attention.
- Clean-up: Promptly clean-up spills, using appropriate protective apparel and equipment and proper disposal. Locate appropriate spill clean-up kits in areas where minor spills may occur.

5.1.2 **Avoidance of "routine" exposure:**

Develop and encourage safe habits. Avoid unnecessary exposure to chemicals by any route. Do not smell or taste chemicals. Vent apparatus, which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices. Inspect gloves and test glove boxes before use. Do not allow release of toxic

substances in cold rooms or warm rooms, because these areas have contained re-circulated atmospheres.

5.1.3 **Choice of chemicals:**
Use only those chemicals for which the quality of the available ventilation system is appropriate.

5.1.4 Eating, smoking, etc.:
Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present. After working in the laboratory, wash hands before conducting these activities. Laboratory apparatus (refrigerators, tools, containers, etc.) are to be used for laboratory purposes only. Food and beverages and their utensils and containers are to remain outside of the laboratory space.

5.1.5 Equipment and glassware:
Handle and store laboratory glassware with care to avoid damage. Do not use damaged glassware. Use extra care with Dewar flasks and other evacuated or pressurized glass apparatus. These should be shielded or wrapped to contain chemicals and fragments should they fracture.

5.1.6 **Exiting:** Wash areas of exposed skin well before leaving the laboratory.

5.1.7 **Horseplay:** Avoid practical jokes or other behavior which might confuse, startle or distract another worker.

5.1.8 **Mouth suction:** Do not use mouth suction for any purpose including pipetting or starting a siphon.

5.1.9 **Personal apparel:** Confine long hair and loose clothing. Close-toed shoes must be worn at all times and should preferably be made of a non-absorbent material (i.e. leather) and have slip-resistant soles. Sandals, perforated shoes and sneakers are not acceptable.

5.1.10 **Personal housekeeping:**
Keep the work area clean and uncluttered with chemicals and equipment being properly labeled and stored. Clean-up the work area upon completion of an operation or at the end of each day.

5.1.11 **Personal protection:**
Assure that appropriate eye protection is worn by all persons, including visitors, where chemicals are stored or handled. Wear appropriate gloves when the potential for contact with toxic materials exists. Inspect the gloves before each use, wash them before removal, and replace them periodically. Use appropriate respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls. Inspect the respirator before use. Use any other protective and emergency apparel and equipment as appropriate. Avoid use of contact lenses in the laboratory. If they are used, the supervisor must approve, in writing, so special precautions can be taken. Remove laboratory coats immediately on significant contamination.

5.1.12 **Planning:**

Seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation. Some chemical properties to consider are:

- Presence of double or triple bounds, e.g., acetylene
- Oxidation or Reduction characteristics, e.g., chromic acid = strong oxidizer
- Acid/base characteristics, e.g., hydrochloric acid = strong acid
- Stability/reactivity, e.g., carbon disulfide and chloroform

5.1.13 **Unattended operations:**

Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of utility service (such as cooling water) to an unattended operation.

5.1.14 **Use of hood:**

Use the hood for operations, which might result in release of toxic chemical vapors or dust. As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance. Confirm adequate hood performance before use. Keep hood closed at all times except when adjustments within the hood are being made. Keep materials stored in hoods to a minimum and do not allow them to block vents or airflow. Leave the hood "on" when it is not in active use if toxic substances are stored in it or it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off."

5.1.15 **Vigilance:**

Be alert to unsafe conditions and see that they are corrected when detected.

5.1.16 **Waste disposal**:

Assure that the plan for each laboratory operation includes plans and training for waste disposal. (See Appendix C) Deposit chemical waste in appropriately labeled receptacles. Do not discharge to the sewer concentrated acids or bases, highly toxic, malodorous, or lachrymatory substances, or to any waste water treatment plants materials which could create fire or explosion hazards, cause structural damage or obstruct flow

5.1.17 **Working alone:**

Do not work alone in the building, another person must be present. If work in the lab is of a particularly hazardous nature then another qualified individual needs to be present in the same room.

5.2 Working with Allergens and Embryotoxins

5.2.1 Allergens (examples: diazomethane, isocyanates, dichromates): Wear suitable gloves to prevent contact with allergens or substances of unknown allergenic activity.

5.2.2 Embryotoxins (examples: organomercurials, lead compounds, formamide): If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance had been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact. Review each use of these materials with the laboratory supervisor and review continuing uses annually or whenever a procedural change is made. Store these substances, properly labeled, in an adequately

ventilated area in and unbreakable secondary container. Notify supervisors of all incidents of exposure or spills. Consult a qualified physician when appropriate.

5.3 **Work with Chemicals of Moderate Chronic or High Acute Toxicity**
(Examples: diisopropylfluorophosphate, hydrofluoric acid, hydrogen cyanide) Supplemental rules to be followed in addition to those mentioned above:

5.3.1 Aim: To minimize exposure to these toxic substances with moderate chronic or high acute toxicity used in significant quantities.

5.3.2 Applicability: These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities.

5.3.3 Location: Use and store these substances only in areas of restricted access with special warning signs. Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 80 linear feet per minute) or other containment device for procedures which may result in generation of aerosols or vapors containing the substance. Trap released vapors to prevent their discharge with the hood exhaust.

5.3.4 Personal protection: Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate). Always wash hands and arms immediately after working with these materials.

5.3.5 Records: Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved.

5.3.6 Prevention of spills and accidents: Be prepared for accidents and spills. Assure that at least two people are present at all times if a compound in use is highly toxic or of unknown toxicity. Store breakable containers of these substances in chemically resistant trays. Also, work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper. If a major spill occurs outside the hood, evacuate the area. Assure that cleanup personnel wear suitable protective apparel and equipment.

5.3.7 Waste: Thoroughly decontaminate or incinerate contaminated clothing or shoes. If possible, chemically decontaminate by chemical conversion. Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite).

5.4 **Work with Chemicals of High Chronic Toxicity**
(Examples: dimethylmercury and nickel carbonyl, benzo-a-pyrene, N-nitrosodiethylamine, other human carcinogens or substances with high carcinogenic potency in animals.)
Further supplemental rules to be followed, in addition to all those mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance).

5.4.1 Access: Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab designated for use of highly toxic substances, for which all people with access are aware of the substance being used and necessary precautions.

5.4.2 Approvals: Prepare a plan for use and disposal of the materials and obtain the approval of the laboratory supervisor.

5.4.3 Non-contamination/Decontamination: Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood. Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area.
Decontaminate the controlled area before normal work is resumed there.

5.4.4 Exiting: On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck.

5.4.5 Housekeeping: Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder.

5.4.6 Medical surveillance: If using toxicologically significant quantities of such a substance on a regular basis (e.g. three times per week), consult a qualified physician concerning desirability of regular medical surveillance.

5.4.7 Records: Keep accurate records of the amounts of these substances stored and used, the dates of use, and names of users.

5.4.8 Signs and labels: Assure that the controlled area is conspicuously marked with warning and restricted access signs and that all containers of these substances are appropriately labeled with identity and warning labels.

5.4.9 Spills: Ensure that contingency plans; equipment, and materials to minimize exposures of people and property in case of accidents are available.

5.4.10 Storage: Store containers of these chemicals only in a ventilated, limited access area in appropriately labeled, unbreakable, chemically resistant, secondary containers.

5.4.11 Glove boxes: For a negative pressure glove box, ventilation rate must be at least two volume changes/hour and pressure at least 0.5 inches of water. For a positive pressure glove box, thoroughly check for leaks before each use. In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood.

5.4.12 Waste: Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel.

5.5 Physical Hazards

Materials that present a physical hazard can be safely used if the specific hazard(s) are understood. If appropriate precautions are not taken, personal injury or property damage may occur. Additionally, certain chemicals cannot be safely mixed or stored with other chemicals because of the danger of a violent reaction or a reaction that generates toxic gas. See Appendix C for a table of common incompatible chemicals.

5.5.1 Flammable Combustible Material: The National Fire Protection Agency (NFPA) places flammable and combustible liquids in the following classes:

Flammable	Flash Point	Boiling point
Class IA	<73˚ F (22.8˚ C)	<100˚ F (37.8˚ C)
Class IB	<73˚ F (22.8˚ C)	≥100˚ F (37.8˚ C)
Class I C	≥ 73˚ F (22.8˚ C)	<100˚ F (37.8˚ C)

Combustible	Flash Point
Class II	≥100˚ F (37.8˚ C) & <140˚ F (60˚ C)
Class II A	≥140 ˚ F (60˚ C) & <200˚ F (93˚ C)
Class III B	≥200˚ F (93˚ C)

These classes give a measure of the fire risk. Appendix D lists some common flammable and combustible chemicals.

Note: The flash point is defined as the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. For handling Flammable/Combustible materials, observe the following guidelines:

5.5.2 Eliminate ignition sources such as open flames, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity.

5.5.3 Store flammable/combustible materials in NFDA approved flammable liquid containers in storage cabinets in areas isolated from ignition sources; See Appendix E for storage capacities.

5.5.4 Ensure there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drain.

5.5.5 Ensure appropriate fire extinguishers and/or sprinklers are in the area and operational.

5.5.6 **Corrosives:** Materials which can react with the skin causing burns similar to thermal burns, and/or which can react with metal causing deterioration of the metal surface. (See Appendix F).

5.5.6.1 Containers and equipment used for storage and processing of corrosive materials should be corrosion resistant.

5.5.6.2 Eye protection and rubber gloves should always be used when handling corrosive materials. A face shield, rubber apron and rubber boots may also be appropriate, depending on the work performed.

5.5.6.3 Do not add water to acid. When diluting concentrated acids, always add acid slowly to water. Using this technique will ensure that if splash-back occurs from the mixing reservoir exposure to concentrated material is minimized.

Notable exception: during sample preparation for metals analysis it may be necessary to add water to acid. Special care must be used in this circumstance

and reservoirs with small openings (i.e. volumetric flasks) selected to minimize potential for splash-back.

5.5.6.4 An eyewash and safety shower must be readily accessible to areas where corrosives are used and stored. In the event of skin or eye contact with corrosives, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Notify the lab director as soon as possible for further assessment.

5.5.7 **Oxidizers:** Materials, which react with other substances by giving off electrons and undergoing reduction. This reaction depends on the oxidizing-reducing potential of the materials involved. See Appendix G for a list of common oxidizers.

5.5.7.1 Know the reactivity of the materials involved in the process. Ensure there are not extraneous materials in the area which could become involved in a reaction.

5.5.7.2 If the reaction is anticipated to be violent or explosive, use shields or other methods for isolating the materials or the process.

5.5.8 **Water Reactive Materials:** Materials, which react with water to produce a flammable or toxic gas or other hazardous condition. Often a fire or explosion results. Safe handling of water reactive materials will depend on the specific material and the conditions of use and storage. Examples of water reactive chemicals include alkali metals such as lithium, sodium, and potassium; acid hydrides, and acid chlorides.

5.5.9 **Pyrophoric Materials:** Materials, which ignite spontaneously upon contact with air. Often the flames are invisible. Pyrophoric chemicals should be used and stored in inert environments. Examples of pyrophoric materials are

5.5.9.1 silane
5.5.9.2 silicon and several of its compounds
5.5.9.3 tetrachlorides of tin or titanium
5.5.9.4 Grignard reagents, RMg_x
5.5.9.5 Metal alkyls and aryls, such as RLi, RNa, R_3Al, R_2Zn
5.5.9.6 Metal carbonyls such as $Ni(CO)_4$, $Fe(CO)_5$, $CO_2(CO)_8$
5.5.9.7 Alkali metals such as Na, K
5.5.9.8 Metal powders, such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr
5.5.9.9 Metal hydrides such as NaH, $LiAlH_4$
5.5.9.10 Nonmetal hydrides, such as B_2H_6 and other boranes, PH_3, AsH_3
5.5.9.11 Nonmetal alkyls, such as R_3B, R_3P, R_3As
5.5.9.12 Phosphorus (white or yellow)

5.5.10 **Peroxidizable Chemicals (Organic Peroxides):** Materials, which undergo auto-oxidation (a reaction with oxygen in the air) to form peroxides, which can explode with impact, heat, or friction. Since these chemicals may be packaged in air atmosphere, peroxides can form even though the container has not been opened, necessitating careful handling. See Appendix H for a list of materials, which may form peroxides.

5.5.10.1 Date all peroxidizables upon receipt and upon opening. Dispose of or check for peroxide formation after the recommended time; three months or one year depending on the chemical. See Appendix H for schedule.

5.5.10.2 Do not open any container, which has obvious solid formation around the lid.

5.5.10.3 It is recommended to chemically test for peroxides periodically.

5.5.10.4 The Addition of an inhibitor to quench the formation of peroxides is recommended. Note: in some instances the use of an inhibitor requires the presence of a small amount of oxygen and therefore the compound in question should not be stored under an inert atmosphere.

5.5.10.5 Follow the same basic handling procedures as for flammable materials.

5.5.11 **Light –Sensitive Materials:** Materials which degrade in the presence of light, could form new compounds that can be hazardous, or result in conditions such as pressure build-up inside a container which may be hazardous. Examples of light sensitive materials include chloroform, tetrahydrofuran, ketones, and anhydrides. Store light sensitive materials in a cool, dark place in amber colored bottles or other containers, which reduce or eliminate penetration of light.

5.5.12 **Unstable Materials:** Compounds, which can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some chemicals become increasingly shock-sensitive with age. Of great concern in the laboratory is the inadvertent formation of explosive or shock-sensitive materials such as provided in Appendix I. Date all containers of explosive or shock sensitive materials upon receipt and when opened.

6. Physical Safety Recommendations

The above recommendations do not include those, which are primarily directed toward prevention of physical injury rather than toxic exposure. Failure of precautions against injury may have the secondary effect of causing toxic exposures. Additionally, consider safety hazards, which may also have implications for chemical hygiene:

- Corrosive Agents.
- Electrically Powered Laboratory Apparatus.
- Fires and Explosions.
- Low Temperature Procedures
- Pressurized and Vacuum Operations (including the use of compressed gas cylinders).

7. Safety Data Sheets

7.1 Background

The OSHA Hazard Communication Standard (HCS) is now aligned with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). This update to the

Hazard Communication Standard (HCS) will provide a common and coherent approach to classifying chemicals and communicating hazard information on labels and safety data sheets. The revised MIOSHA Part 42, 92, & 430 Hazard Communication standard will improve the quality and consistency of hazard information in the workplace, making it safer for workers by providing easily understandable information on appropriate handling and safe use of hazardous chemicals.

7.2 Purpose

Safety Data Sheets (SDSs) are forms provided by chemical manufacturers to identify hazards and physical properties for a specific chemical or substance as well as to give toxicological data and recommendations for PPE, first-aid, and spill clean-up. Although manufacturers are required to provide certain information, the quality and depth of the information on the SDSs may vary widely. Some substances, such as research chemicals sold in small quantities, may not have an SDS. You may contact the manufacturer directly for pertinent health and safety information. The SDSs are located in the short set of labeled file cabinets near the copier and mailing supplies. The lab director, quality manager, or informed staff may assist directing to the relevant files.

7.3 Accessibility

SDSs for all chemicals used in a work place should be readily accessible to all laboratory staff upon request. Individual sheets should be provided upon request within a workday. Sheets may be stored at each work area (filed by CAS number or chemical name) or may be stored in a central location within the agency. The CAS number may be located in the CIM, certificates of analysis, Merck manual, or online services such a www.chemfinder.com and www.sigma.com. The lab director, quality manager, or informed staff may assist locating the relevant CAS #'s.

7.4 Responsibility

It is the responsibility of the Chemical Hygiene Officer to see that SDSs are maintained and are accessible. The lab supervisor is responsible for reviewing SDSs upon initial receipt for new chemicals to evaluate any special precautions. Laboratory staff who receive chemicals are responsible for forwarding SDSs through their supervisor to the office for filing or forwarding to a central file. The most recent SDSs are filed and replace any older SDSs.

APPENDIX A

MIOSHA-STD-1212 (09/06)
12 Pages

DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS

DIRECTOR'S OFFICE

OCCUPATIONAL HEALTH STANDARDS

Filed with the Secretary of State on January 9, 1992 **(as amended July 28, 2003)**

These rules take effect 7 days after filing with the Secretary of State

(By authority conferred on the director of the department of consumer and industry services by sections 14 and 24 of 1974 PA 154 and Executive Reorganization Orders Nos. 1996-1 and 1996-2, MCL 408.1014, 408.1024, 330.3101, and 445.2001)

R 325.70101, R 325.70102, R 325.70103, R 325.70104, R 325.70105, R 325.70106, R 325.70107, R 325.70108, R 325.70109, R 325.70110, R 325.70111, R 325.70113, and R 325.70114 of the Michigan Administrative Code are amended and R 325.70112 of the Michigan Administrative Code is rescinded as follows:

PART 431. HAZARDOUS WORK IN LABORATORIES

R 325.70101 Scope; effective date of subrule (2)

Rule 1. (1) These rules set forth the requirements for laboratory use of hazardous chemicals. Subjects to which these rules apply include all of the following:

(a) Exposure limits.
(b) Exposure monitoring.
(c) Written chemical hygiene plan.
(d) Employee information and training.
(e) Medical surveillance.
(f) Hazard identification.
(g) Use of respiratory protection.
(h) Recordkeeping.

(2) These rules, where they apply as specified in R 325.70102, supersede all Michigan occupational safety and health act (MIOSHA) occupational health standards that govern the use of specific chemical substances, except as provided in R 325.70104, R 325.70105, and R 325.70108. Also, where they apply, these rules supersede the requirements of the occupational safety and health administration (OSHA) hazard communication standard, being 29 C.F.R. §1910.1200, which is incorporated by section 14a of 1974 PA 154, MCL 408.1014a. This subrule takes effect when an employer has developed and implemented a written chemical hygiene plan as prescribed by R 325.70106.

(3) All occupational health standards that do not deal with a specific chemical substance apply to laboratory operations as do any occupational safety standards administered by the Michigan department of consumer and industry services. Such non-chemical substance standards that apply to laboratory operations include all of the following rules:

(a) Occupational noise exposure, Part 380., R 325.60101 et seq.
(b) Ionizing radiation, Part 381., O.H. 2410 et seq.
(c) Nonionizing radiation, Part 382., R 325.60701 et seq.
(d) Ventilation control, Part 520., O.H. 3101 et seq.
(e) Permit-required confined spaces, Part 490., R 325.63001 et seq.
(f) Respiratory protection, Part 451., R 325.60051 et seq.
(g) Illumination, Part 478., R 325.47801 et seq.

(h) Sanitation, Part 474., O.H. 4201 et seq.
(i) Medical services and first aid, Part 472., R 325.47201 et seq.
(j) Employee medical records and trade secrets, Part 470., R 325.3451 et seq.

R 325.70102 Application

Rule 2. (1) These rules apply to all employers who have an employee or employees involved in the laboratory use of hazardous chemicals as defined in R 325.70103.

(2) These rules do not apply to either of the following:

(a) Work involving chemicals that do not meet the conditions of the definition of laboratory use of hazardous chemicals. In such cases, the employer shall comply with all relevant specific substance standards even if such use occurs in a laboratory type setting.

(b) Work involving the laboratory use of hazardous chemicals that does not have the potential for employee exposure.

R 325.70103 Definitions

Rule 3. As used in these rules:

(a) **"Action level"** means a concentration which is designated in established MIOSHA health standards for a specific substance, calculated as an 8-hour, time-weighted average, and which initiates certain required activities, such as exposure monitoring and medical surveillance.

(b) **"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.

(c) **"Chemical hygiene plan"** means a written program which is developed and implemented by the employer, which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by the hazardous chemicals used in a particular workplace, and which is in compliance with the requirements of R 325.70106.

(d) **"Director"** means the director of the Michigan department of consumer and industry services or his or her designee.

(e) **"Emergency"** means any occurrence, such as equipment failure, the rupture of containers, or the failure of control equipment, that results in an uncontrolled release of a hazardous chemical into the workplace.

(f) **"Employee"** means a person who is assigned to work in a laboratory workplace and who may be exposed to hazardous chemicals in the course of his or her assignments.

(g) **"Hazardous chemical"** means a chemical for which there is statistically significant evidence, based on at least 1 study that is conducted in accordance with established scientific principles, that acute or chronic health effects may occur in employees who are exposed to the chemical. These health effects include those that result from exposure to chemicals which are any of the following:
(i) Carcinogens.
(ii) Toxic or highly toxic agents.
(iii) Reproductive toxins.
(iv) Irritants.
(v) Corrosives.
(vi) Sensitizers.
(vii) Hepatotoxins.
(viii) Nephrotoxins.
(ix) Neurotoxins.
(x) Agents that act on the hematopoietic systems.
(xi) Agents that damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the OSHA hazard communications standard, being 29 C.F.R. §1910.1200 and referenced in R 325.70101(2), 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 these rules.

(h) **"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 nonproduction basis.

(i) **"Laboratory-type hood"** means a work chamber which is used in a laboratory, which is enclosed on 5 sides and has a moveable sash or fixed partial closure on the remaining side, which is constructed and maintained to draw air from the laboratory and prevent or minimize the escape of air contaminants into the laboratory, and which allows chemical manipulations to be conducted in the enclosure without inserting any portion of the employee's body other than hands and arms. The term includes walk-in hoods with adjustable sashes if the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and so that employees do not work inside the enclosure during the release of airborne hazardous chemicals.

(j) **"Laboratory use of hazardous chemicals"** means the 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 that are involved are not part of production process, nor in any way simulate a production process.
(iv) Protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

(k) **"Medical consultation"** means a consultation that takes place between an employee and a licensed physician to determine what medical

examinations or procedures, if any, are appropriate.

(l) **"Physical hazard"** means a chemical for which there is scientifically valid evidence that it is any of the following:
(i) A combustible liquid.
(ii) A compressed gas.
(iii) Explosive.
(iv) Flammable.
(v) An organic peroxide.
(vi) An oxidizer.
(vii) Pyrophoric.
(viii) Unstable (reactive).
(ix) Water-reactive.

These terms are defined in appendix B of these rules.

(m) **"Production"** means the manufacturing processes that use hazardous chemicals and result in a product.

(n) **"Protective laboratory practices and equipment"** means those laboratory procedures, practices, and equipment that are 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.

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

(p) **"Select carcinogen"** means any substance that meets 1 or more of the criteria set forth in the definition of select carcinogen in paragraph (b) of OSHA standard 29 C.F.R. §1910.1450, which is adopted herein by reference. The cited provision of 29 C.F.R. §1910.1450 is available from the Michigan Department of Consumer and Industry Services, Standards Division, P.O. Box 30643, Lansing, Michigan 48909, at no cost, or from the U.S. Department of Labor, OSHA, 801 S. Waverly, Suite 306, Lansing, Michigan 48917, at no cost. The cited definition is printed as appendix C to these rules.

R 325.70104 Permissible exposure limits

Rule 4. For laboratory uses of MIOSHA-regulated substances, an employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in MIOSHA occupational health standards.

R 325.70105 Exposure monitoring

Rule 5. (1) An employer shall measure an employee's exposure to any substance that is regulated by a standard that 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 permissible exposure limits (PEL).

(2) If the initial monitoring prescribed by subrule (1) of this rule discloses employee exposure over the action level or, in the absence of an action level, the PEL, an employer shall comply with the exposure monitoring provisions of the relevant standard.

(3) Monitoring may be terminated in accordance with the relevant standard.

(4) An employer shall, within 15 working days after the receipt of any monitoring results, notify an employee of these results, in writing, either individually or by posting the results in an appropriate location that is accessible to employees.

R 325.70106 Chemical hygiene plan

Rule 6. (1) Where hazardous chemicals as defined by these rules are used in the workplace, an employer shall develop and carry out the provisions of a written chemical hygiene plan that provides for both of the following:
(a) Protecting employees from health hazards that are associated with hazardous chemicals in that laboratory.
(b) Keeping exposures below the limits specified in R 325.70104.

(2) The chemical hygiene plan shall be readily available to employees, employee representatives, and, upon request, to the director.

(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:
(a) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals.
(b) 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 particularly hazardous.
(c) A requirement that laboratory-type hoods and other protective equipment are functioning properly and the specific measures that shall be taken to ensure the proper and adequate performance of such equipment.
(d) Provisions for employee information and training as prescribed in R 325.70107.
(e) 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.
(f) Provisions for medical consultation and medical examinations in accordance with R 325.70108.
(g) Designation of personnel who are responsible for implementing the chemical hygiene plan, including the assignment of a chemical hygiene officer and, if appropriate, establishment of a chemical hygiene committee.
(h) Provisions for additional employee protection for work with particularly hazardous substances, such as select carcinogens, reproductive toxins, and substances that have a high degree of acute or chronic toxicity. Specific consideration shall be given to the following provisions, which shall be included where appropriate:
(i) The establishment of a designated area or areas that indicate the physical limits of

exposure to particularly hazardous substances.

(ii) The use of containment devices, such as laboratory-type hoods or glove boxes.

(iii) Procedures for the safe removal of contaminated waste.

(iv) Decontamination procedures.

(4) An employer shall review and evaluate the effectiveness of the chemical hygiene plan at least annually and update it as necessary.

(5) Appendix A to these rules is nonmandatory, but provides guidance to assist employers in the development of a chemical hygiene plan.

R 325.70107 Employee information and training

Rule 7. (1) An employer shall provide employees with information and training to ensure that they are apprised of and understand the hazards of chemicals present in their work areas.

(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 before assignments that involve new exposure situations. Refresher information and training shall be provided by the employer to ensure that an employee is aware of the risks of exposure to hazardous chemicals.

(3) Employees shall be informed of all of the following:

(a) The contents of these rules and appendices, which shall be made available to employees.

(b) The location and availability of the employer's chemical hygiene plan.

(c) The permissible exposure limits for MIOSHA-regulated substances or the recommended exposure limits for other hazardous chemicals if there are no applicable MIOSHA rules.

(d) Signs and symptoms associated with exposures to hazardous chemicals that are used in the laboratory.

(e) The location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory, including material safety data sheets (MSDS) received from a chemical supplier.

(4) Employee training shall include all of the following:

(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, and the visual appearance or odor of hazardous chemicals when being released.

(b) The physical and health hazards of chemicals in the work environment.

(c) The measures employees can take to protect themselves from health hazards, including specific procedures that the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

(5) The employee shall be trained about the applicable details of the employer's written chemical hygiene plan.

R 325.70108 Medical surveillance

Rule 8. (1) An employer shall provide all employees who work with hazardous chemicals an opportunity to receive the following medical attention, including any follow-up examinations which the examining physician determines to be necessary:

(a) When an employee develops signs or symptoms that are 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.

(b) If exposure monitoring reveals an exposure level that is routinely above the action level or, in the absence of an action level, the PEL for a MIOSHA-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.

(c) When an event takes place in the work areas, such as a spill, leak, explosion, or other occurrence that results 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 who is familiar with the general health effects of hazardous chemicals and sources of specific information on such effects and shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

(3) An employer shall provide all of the following information to the physician:

(a) The identity of the hazardous chemical or chemicals to which the employee may have been exposed.

(b) A description of the conditions under which the exposure occurred, including quantitative exposure data, if available.

(c) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

(4) For examination or consultation that is required under this rule, an employer shall obtain a written opinion from the examining physician. The opinion shall include all of 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 revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical that is found in the workplace.

(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.

(5) The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

R 325.70109 Hazard identification

Rule 9. (1) With respect to labels and material safety data sheets (MSDS) for hazardous chemicals, both of the following provisions apply:

(a) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

(b) Employers shall maintain any MSDS that are received with incoming shipments of hazardous chemicals and ensure that MSDS are readily accessible to laboratory employees.

(2) All of the following provisions shall apply to chemical substances that are developed in the laboratory:

(a) If the composition of the chemical substance that is produced exclusively for the laboratory's use is known, an employer shall determine if it is a hazardous chemical. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required by R 325.70107.

(b) If the chemical produced is a by-product of unknown composition, an employer shall assume that the substance is hazardous and shall implement the provisions of R 325.70106.

(c) If the chemical substance is produced for another user outside of a laboratory, an employer shall comply with the OSHA hazard communication standard, being 29 C.F.R. §1910.1200, which is referenced in R 325.70101.

R 325.70110 Use of respiratory protection

Rule 10. If, after appropriate application of feasible engineering and work practice controls, 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 protection equipment. Respirators shall be selected and used in accordance with the requirements of respiratory protection, Part 451., R 325.60051 et seq.

R 325.70111 Recordkeeping

Rule 11. (1) An 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 these rules.

(2) An employer shall assure that such records are kept, transferred, and made available in accordance with the provisions of employee medical records and trade secrets, Part 470., R 325.3451 et seq., and are protected from unauthorized disclosure.

R 325.70112 Rescinded

R 325.70113 Appendices

Rule 13. Appendices A, B, C, and D to these rules are informational only and are not intended to create any additional obligations or requirements not otherwise imposed by these rules or to detract from any established obligations or requirements.

R 325.70114 Availability of rules and appendices; permission to copy

Rule 14. (1) A copy of these rules and appendices are available at no cost from the Michigan Department of Consumer and Industry Services, Standards Division, P.O. Box 30643, Lansing, Michigan 48909.

(2) Permission to copy any of these documents in full is granted by the director.

APPENDICES TO MIOSHA STANDARD HAZARDOUS WORK IN LABORATORIES R 325.70101-R 325.70114

The following appendices (A-D) are provided as nonmandatory guidelines and information to assist employers and employees to understand and comply with provisions of the standard. Appendix A is similar to the comparable appendix to 29 CFR §1910.1450 which is the Federal OSHA standard from which these rules were derived.

APPENDIX A--CHEMICAL HYGIENE IN LABORATORIES

The material in this appendix outlines concerns and recommendations for effectively dealing with chemical hazards in the laboratory environment. Naturally, not all items are appropriate for all laboratories. In most situations a study of this appendix and the provisions of Rule 6(3) will be sufficient to enable an effective chemical hygiene plan to be written.

The following table indicates the part of this appendix which are most pertinent to each of the subdivisions of Subrule (3) of Rule 6.

Subdivision of Rule 6(3)	Relevant Appendix A Section
(a) SOP for working with hazardous chemicals	C., D., E.
(b) Control measures	D.
(c) Laboratory fume hoods	C. 4. (b)
(d) Information and training	D. 10.
(e) Approval of operations	E. 2. (b), E. 4. (b)
(f) Medical consultation/exams	D. 5., E. 4. (f)
(g) Chemical hygiene officer	B.
(h) Special precautions	E. 2., 3., 4.

A. General Principles for Work with Laboratory Chemicals

1. It is prudent to minimize all chemical exposures. Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals. Skin contact with chemicals should be avoided as a cardinal rule.

2. Avoid underestimation of risk. Even for substances of no known significant hazard, exposure should be minimized; for work with substances which present special hazards, special precautions should be taken. One should assume that any mixture will be more toxic than its most toxic component and that all substances of unknown toxicity are toxic.

3. Provide adequate ventilation. The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices.

4. Institute a chemical hygiene program. A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity. Its recommendations should be followed in academic teaching laboratories as well as by full-time laboratory workers.

5. Observe the PELs, TLVs. The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded.

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rests at all levels including the:

1. Chief executive officer, who has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene.

2. Supervisor of the department or other administrative unit, who is responsible for chemical hygiene in that unit.

3. Chemical hygiene officer(s), whose appointment is essential and who must:
   (a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices;
   (b) Monitor procurement, use, and disposal of chemicals used in the lab;
   (c) See that appropriate audits are maintained;
   (d) Help project directors develop precautions and adequate facilities;
   (e) Know the current legal requirements concerning regulated substances; and
   (f) Seek ways to improve the chemical hygiene program.

4. Laboratory supervisor, who has overall responsibility for chemical hygiene in the laboratory including responsibility to:
   (a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided;
   (b) Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment;
   (c) Know the current legal requirements concerning regulated substances;
   (d) Determine the required levels of protective apparel and equipment; and
   (e) Ensure that facilities and training for use of any material being ordered are adequate.

5. Project director or director of other specific operation, who has primary responsibility for chemical hygiene procedures for that operation.

6. Laboratory worker, who is responsible for:
   (a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures; and
   (b) Developing good personal chemical hygiene habits.

C. The Laboratory Facility

1. Design. The laboratory facility should have:
   (a) An appropriate general ventilation system (see C.4. below) with air intakes and exhausts located so as to avoid intake of contaminated air;
   (b) Adequate, well-ventilated stockrooms/ storerooms;
   (c) Laboratory hoods and sinks;
   (d) Other safety equipment including eyewash fountains and drench showers; and
   (e) Arrangements for waste disposal.

2. Maintenance. Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continuing appraisal and be modified if inadequate.

3. Usage. The work conducted and its scale must be appropriate to the physical facilities available and, especially, to the quality of ventilation.

4. Ventilation
   (a) General laboratory ventilation. This system should: Provide a source of air for breathing and for input to local ventilation devices; it should not be relied on for protection from toxic substances released into the laboratory; ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day; direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building.
   (b) Hoods. A laboratory hood with 2.5 linear feet of hood space per person should be provided for every two workers if they spend most of their time working with chemicals; each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use. If this is not possible, work with substances of unknown toxicity should be avoided or other types of local ventilation devices should be provided.

(c) Other local ventilation devices. Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed. Each canopy hood and snorkel should have a separate exhaust duct.

(d) Special ventilation areas. Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system. Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure.

(e) Modifications. Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate.

(f) Performance. Rate: 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control.

(g) Quality. General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas; airflow into and within the hood should not be excessively turbulent; hood face velocity should be adequate (typically 60-100 lfm).

(h) Evaluation. Quality and quantity of ventilation should be evaluated on installation, regularly monitored (at least every 3 months), and reevaluated whenever a change in local ventilation devices is made.

D. Components of the Chemical Hygiene Plan

1. Basic Rules and Procedures
(Recommendations for these are given in section E, below)

2. Chemical Procurement, Distribution, and Storage
   (a) Procurement. Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved. No container should be accepted without an adequate identifying label. Preferably, all substances should be received in a central location.
   (b) Stockrooms/storerooms. Toxic substances should be segregated in a well-identified area with local exhaust ventilation. Chemicals which are highly toxic or other chemicals whose containers have been opened should be in unbreakable secondary containers. Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity.
   Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person.
   (c) Distribution. When chemicals are hand carried, the container should be placed in an outside container or bucket. Freight-only elevators should be used if possible.
   (d) Laboratory storage. Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom.

3. Environmental Monitoring
Regular instrumental monitoring of airborne concentrations is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devices or when a highly toxic substance is stored or used regularly (e.g., 3 times/week).

4. Housekeeping, Maintenance, and Inspections
   (a) Cleaning. Floors should be cleaned regularly.
   (b) Inspections. Formal housekeeping and chemical hygiene inspections should be held at least quarterly for units which have frequent personnel changes and semiannually for others; informal inspections should be continual.
   (c) Maintenance. Eye wash fountains should be inspected at intervals of not less than 3 months. Respirators for routine use should be inspected periodically by the laboratory supervisor. Safety showers should be tested routinely. Other safety equipment should be inspected regularly. (e.g., every 3-6 months). Procedures to prevent restarting of out-of-service equipment should be established.
   (d) Passageways. Stairways and hallways should not be used as storage areas. Access to exits, emergency equipment, and utility controls should never be blocked.

5. Medical Program
   (a) Compliance with regulations. Regular medical surveillance should be established to the extent required by regulations.
   (b) Routine surveillance. Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable.
   (c) First aid. Personnel trained in first aid should be available during working hours and an emergency room with medical personnel should be nearby.

6. Protective Apparel and Equipment--should include for each laboratory:
   (a) Protective apparel compatible with the required degree of protection for substances being handled;
   (b) An easily accessible drench-type safety shower;
   (c) An eyewash fountain;
   (d) A fire extinguisher;
   (e) Respiratory protection, fire alarm and telephone for emergency use should be available nearby; and
   (f) Other items designated by the laboratory supervisor.

7. Records
   (a) Accident records should be written and retained.
   (b) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations.

(c) Inventory and usage records for high-risk substances should be kept as specified in sections E.3.(e) below.
(d) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations.

8. Signs and Labels
Prominent signs and labels of the following types should be posted:
(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers;
(b) Identity labels, showing contents of containers (including waste receptacles) and associated hazards;
(c) Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits and areas where food and beverage consumption and storage are permitted; and
(d) Warnings at areas or equipment where special or unusual hazards exist.

9. Spills and Accidents
(a) A written emergency plan should be established and communicated to all personnel; it should include procedures for ventilation failure, evacuation, medical care, reporting, and drills.
(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms.
(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting.
(d) All accidents or near accidents should be carefully analyzed with the results distributed to all who might benefit.

10. Information and Training Program
(a) Aim: To assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs.
(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment.
Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures.
Such training as well as first aid instruction should be available to and encouraged for everyone who might need it.
(c) Receiving and stockroom/storeroom personnel should know about hazards, handling equipment, protective apparel, and relevant regulations.
(d) Frequency of Training: The training and education program should be a regular, continuing activity--not simply an annual presentation.
(e) Literature/Consultation: Literature and consulting advice concerning chemical hygiene should be readily available to laboratory personnel, who should be encouraged to use these information resources.

11. Waste Disposal Program.
(a) Aim: To assure that minimal harm to people, other organisms, and the environment will result from the disposal of waste laboratory chemicals.
(b) The waste disposal program should specify how waste is to be collected, segregated, stored, and transported and include consideration of what materials can be incinerated. Transport from the institution must be in accordance with DOT regulations.
(c) Discarding Chemical Stocks: Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened.
Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage.
(d) Frequency of Disposal: Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals.
(e) Method of Disposal: Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste.
Indiscriminate disposal by pouring waste chemicals down the drain or adding them to mixed refuse for landfill burial is unacceptable.
Hoods should not be used as a means of disposal for volatile chemicals.
Disposal by recycling or chemical decontamination should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan should require that laboratory workers know and follow its rules and procedures. In addition to the procedures of the sub programs mentioned above, these should include the rules listed below.

1. General Rules/Recommendations
The following should be used for essentially all laboratory work with chemicals:
(a) Accidents and spills--Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention.
Ingestion: Encourage the victim to drink large amounts of water.
Skin Contact: Promptly flush the affected area with water and remove any contaminated clothing. If symptoms persist after washing, seek medical attention.
Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal.
(b) Avoidance of "routine" exposure: Develop and encourage safe habits; avoid unnecessary exposure to chemicals by any route.
Do not smell or taste chemicals. Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices.
Inspect gloves and test glove boxes before use.
Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres.

(c) Choice of chemicals: Use only those chemicals for which the quality of the available ventilation system is appropriate.

(d) Eating, smoking, etc.: Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present; wash hands before conducting these activities.
Avoid storage, handling or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations.

(e) Equipment and glassware: Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur. Use equipment only for its designed purpose.

(f) Exiting: Wash areas of exposed skin well before leaving the laboratory.

(g) Horseplay: Avoid practical jokes or other behavior which might confuse, startle or distract another worker.

(h) Mouth suction: Do not use mouth suction for pipeting or starting a siphon.

(i) Personal apparel: Confine long hair and loose clothing. Wear shoes at all times in the laboratory but do not wear sandals, perforated shoes, or sneakers.

(j) Personal housekeeping: Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day.

(k) Personal protection: Assure that appropriate eye protection is worn by all persons, including visitors, where chemicals are stored or handled.
Wear appropriate gloves when the potential for contact with toxic materials exists; inspect the gloves before each use, wash them before removal, and replace them periodically.
Use appropriate respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls, inspecting the respirator before use.
Use any other protective and emergency apparel and equipment as appropriate.
Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken.
Remove laboratory coats immediately on significant contamination.

(l) Planning: Seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation.

(m) Unattended operations: Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation

(n) Use of hood: Use the hood for operations which might result in release of toxic chemical vapors or dust.
As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm.
Confirm adequate hood performance before use; keep hood closed at all times except when adjustments within the hood are being made; keep materials stored in hoods to a minimum and do not allow them to block vents or air flow.
Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off".

(o) Vigilance: Be alert to unsafe conditions and see that they are corrected when detected.

(p) Waste disposal: Assure that the plan for each laboratory operation includes plans and training for waste disposal.
Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan.
Do not discharge to the sewer concentrated acids or bases; highly toxic, malodorous, or lachrymatory substances; or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow.

(q) Working alone: Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous.

2. Working with Allergens and Embryotoxins

(a) Allergens (examples: diazomethane, isocyanates, bichromates): Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity.

(b) Embryotoxins (examples: organomercurials, lead compounds, formamide): If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact.
Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made.
Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container. Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

3. Work with Chemicals of Moderate Chronic or High Acute Toxicity
Supplemental rules to be followed in addition to those mentioned above:

(a) Aim: To minimize exposure to these toxic substances by any route using all reasonable precautions.

(b) Applicability: These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities.

(c) Location: Use and store these substances only in areas of restricted access with special warning signs.
Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance; trap released vapors to revent their discharge with the hood exhaust.

(d) Personal protection: Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate). Always wash hands and arms immediately after working with these materials.

(e) Records: Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved.

(f) Prevention of spills and accidents: Be prepared for accidents and spills.
Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity.
Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper.
If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment.

(g) Waste: Thoroughly decontaminate or incinerate contaminated clothing or shoes. If possible, chemically decontaminate by chemical conversion.
Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite).

4. Work with Chemicals of High Chronic Toxicity
(Examples: dimethylmercury and nickel carbonyl, benzo-a-pyrene, N-nitrosodiethylamine, other human carcinogens or substances with high carcinogenic potency in animals.)
Further supplemental rules to be followed, in addition to all these mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance).

(a) Access: Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all people with access are aware of the substances being used and necessary precautions.

(b) Approvals: Prepare a plan for use and disposal of these materials and obtain the approval of the laboratory supervisor.

(c) Non-contamination/Decontamination: Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood. Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area.
Decontaminate the controlled area before normal work is resumed there.

(d) Exiting: On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck.

(e) Housekeeping: Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder.

(f) Medical surveillance: If using toxicologically significant quantities of such a substance on a regular basis (e.g., 3 times per week), consult a qualified physician concerning desirability of regular medical surveillance.

(g) Records: Keep accurate records of the amounts of these substances stored and used, the dates of use, and names of users.

(h) Signs and labels: Assure that the controlled area is conspicuously marked with warning and restricted access signs and that all containers of these substances are appropriately labeled with identity and warning labels.

(i) Spills: Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available.

(j) Storage: Store containers of these chemicals only in a ventilated, limited access area in appropriately labeled, unbreakable, chemically resistant, secondary containers.

(k) Glove boxes: For a negative pressure glove box, ventilation rate must be at least two volume changes/hour and pressure at least 0.5 inches of water. For a positive pressure glove box, thoroughly check for leaks before each use. In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood.

(l) Waste: Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel.

5. Animal Work with Chemicals of High Chronic Toxicity

(a) Access: For large scale studies, special facilities with restricted access are preferable.

(b) Administration of the toxic substance: When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters.

(c) Aerosol suppression: Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood).

(d) Personal protection: When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator).

(e) Waste disposal: Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-

toxic products; otherwise, package the waste appropriately for burial in an EPA-approved site.

APPENDIX B--DEFINITIONS OF PHYSICAL HAZARDS

Following are the definitions of physical hazards as used in R 325.70103(l). All definitions except that for pyrophoric are those used in the comparable Federal OSHA standard 29 CFR 1910.1450.

(a) "Combustible liquid" means any liquid having a flashpoint at or above 100°F (37.8°C), but below 200°F (93.3°C), except any mixture having components with flashpoints of 200°F (93.3°C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

(b) "Compressed gas" means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D-323-72.

(c) "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.

(d) "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°F (37.8°C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make 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.

(e) "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°F (37.8°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 Flash Point 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°F (37.8°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.

(f) "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 has been replaced by an organic radical.

(g) "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.

(h) "Pyrophoric" means any liquid or solid that will ignite spontaneously in air at about 130°F (54.4°C).

(i) "Unstable (reactive)" means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, pressure, or temperature.

(j) "Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

APPENDIX C--DEFINITION OF SELECT CARCINOGEN

Following is an exact copy of the definition of select carcinogen from paragraph (b) Definitions of 29 CFR §1910.1450:

"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

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonable 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/m^3,

(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.

APPENDIX D--REFERENCES

The following references are provided to assist employers in the development and implementation of a chemical hygiene plan. References listed here do not imply specific endorsement or approval of the material. Other references may better meet the needs of a particular laboratory situation.

A. References for Development of the Chemical Hygiene Plan.

1. American Chemical Society.
   (a) Safety in Academic Chemistry Laboratories, fourth edition, 1985.
   (b) Developing a Chemical Hygiene Plan, 1990., ACS, Distribution Office Dept. 404. P.O. Box 57136, West End Station, Washington, DC 20037 (phone 800-227-5558).
2. Fawcett, H.H. and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, John Wiley & Sons, One Wiley Drive, Somerset, N.J. 08875-9977, 1982.
3. Flury, P.A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield, IL, 1978.
4. Hearn, L.C., et al, OSHA Laboratory Standard Implementation Guide, Lewis Publishers, Inc., 2000 Corporate Blvd., NW, Boca Raton, FL 33431, 1991.
5. National Institute of Health, NIH Guidelines for the Laboratory Use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.
6. National Research Council.
   (a) Prudent Practices for Disposal of Chemicals for Laboratories, 1983.
   (b) Prudent Practices for Handling Hazardous Chemicals in Laboratories, 1981. National Academy Press, Washington, DC.
7. Ouellette, R.P., et al, Safety, Health and the Lab, published in June/July 1991 issue of Environmental Lab.
8. Professional Associates in Regulatory Services, OSHA Laboratory Standard - Chemical Hygiene Plan, 1987, available from A.C.G.I.H. 6500 Glenway Avenue, Cincinnati, OH 45211-4438, phone 513-661-7881.
9. Stricoff, R.S., and D.B. Walters, Laboratory Health and Safety Handbook, John Wiley & Sons (See list No. 2), 1990.
10. Young, J.A., Ed., Improving Safety in the Chemical Laboratory, John Wiley & Sons (See list No. 2), 1987.

B. References for Hazardous Chemical Information.

1. American Conference of Governmental Industrial Hygienists.
   (a) Guide to Occupational Exposure Values.
   (b) Threshold Limit Values and Biological Exposure Indices.
2. Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, GPO., Washington, DC 20402, (latest edition).
3. Best Company, Best Safety Directory, Vols. I and II, Oldurick, NJ, 1981.
4. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, NY 12210, (latest edition).
5. The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals, Merck and Co. Inc., Rahway, NJ, (latest edition).
6. MIOSHA Occupational Health Standards for General Industry, Standards Division, Michigan Department of Consumer and Industry Services, P.O. Box 30643, Lansing, MI 48909. Website address: www.michigan.gov/mioshastandards.
7. Sax, N.I., Dangerous Properties of Industrial Materials, Van Nostrand Reinhold, NY, NY.
8. Sittig, M., Handbook of Toxic and Hazardous Chemicals and Carcinogens, Noyes Publications, Park Ridge, NJ 1985.

C. References for Ventilation Control Information.

1. American Conference of Governmental Industrial Hygienists.
   (a) Industrial Ventilation: A Manual of Recommended Practice, (latest edition).
   (b) Burton, D.J., Laboratory Ventilation Workbook, 1991.
   (c) Pipitone, D.A., Safe Storage of Laboratory Chemicals, 1991, ACGIH, 6500 Glenway Avenue, Cincinnati, OH 45211-4438, phone 513-661-7881.
2. American National Standards Institute, Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z 9.2-1979, ANSI, 1430 Broadway, New York City, NY 10018.
3. Caplan, P.E., and Knutson, G.W., A Performance Test for Laboratory Fume Hoods, in American Industrial Hygiene Association Journal, October 1982.
4. National Fire Protection Association.
   (a) Fire Protection for Laboratories Using Chemicals, NFPA-45, 1982.
   (b) Fire Protection Guide on Hazardous Materials, (latest edition).
   (c) Safety Standard for Laboratories in Health Related Institutions, NFPA-56C, 1980, NFPA, 470 Atlantic Avenue, Boston, MA 02210.
5. Scientific Apparatus Makers Association, Standard for Laboratory Fume Hoods, SAMA LF7-1980, SAMA, 1101 16th Street, NW, Washington, DC 20036.

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APPENDIX B

CARCINOGENS

The list below is a compilation of substances classified as carcinogens by either the Michigan Occupational Safety and Health Administration (MIOSHA), the International Acency for Research on Cancer (IARC) or the National Toxicology Program (NTP). Some of these substances are classified as "Select Carcinogens" and require special work practices. See section 1.4 for the definition of "Select Carcinogen"

Chemical Name	MIOSHA[a]	IARC[b]	NTP[c]
Acetaldehyde		2B	2
Acetamide		2B	
2-Acetylaminofluorene	Class A		2
Acrylamide		2A	2
Acrylonitrile	CH	2B	2
Adriamycin		2A	2
AF-2 (2-(2-Furyl)-3-(5-nitro-2-furyl)acrylamide)		2B	
Aflatoxin M1		2B	
Aflatoxins, naturally occurring		1	1
A-⟨-C (2-amino-9H-pyrido[2,3-b]indole)		2B	
2-Aminoanthraquinone			2
p-Aminoazobenzene		2B	
o-Aminoazotoluene		2B	2
4-Aminobiphenyl	Class A	1	1
1-Amino-2-methylanthraquinone			2
2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole		2B	
Amitrole		2B	2
Amsacrine		2B	
Analgesic mixtures containing phenacetin		1	1
Androgenic (anabolic) steroid		2A	
o-Anisidine		2B	
o-Anisidine hydrochloride			2
Antimony trioxide		2B	
Aramite		2B	
Arsenic and compounds	CH	1	1
Asbestos	CH	1	1
Asbestos, actinolite	CH		
Asbestos, anthophylite	CH		
Asbestos, tremolite	CH		
Auramine (technical-grade)		2B	
Azacitidine		2A	2
Azaserine		2B	
Azathioprine		1	1
Benzal chloride		2A	
Benz[a]anthracene		2A	2
Benzene	CH	1	1
Benzidine	Class A	1	1
Benzidine-based dyes		2A	
Benzo[a]pyrene		2A	2
Benzo[b]fluoranthene		2B	2
Benzo[j]fluoranthene		2B	2
Benzo[k]fluoranthene		2B	2
Benzofuran		2B	

Chemical Name	MIOSHA[a]	IARC[b]	NTP[c]
Benzotrichloride		2A	2
Benzoyl chloride		2A	
Benzyl chloride		2A	
Benzyl violet 4B		2B	
2,2-Bis(bromomethyl)propane-1,3-diol		2B	
Beryllium and certain compounds		1	2
Betel quid with tobacco		1	
N,N-Bis(2-chloroethyl)-2-naphthylamine (chlornaphazine)		1	
Bis(chloromethyl)ether (technical grade)	Class A	1	1
Bischloroethyl nitrosourea (BCNU)		2A	2
Bleomycins		2B	
Bracken fern		2B	
Bromodichloromethane		2B	2
1,3-Butadiene		2A	1
1,4-Butanediol dimethanesulfonate (Busulphan Myleran)		1	1
Butylated hydroxyanisole (BHA)		2B	2
β-Butyrolactone		2B	
C.I. Acid Red 114		2B	
C.I. Basic Red 9		2B	2
C.I. Direct Blue 15		2B	
C.I. Citrus Red no. 2		2B	
Cadmium and compounds	CH	1	1
Caffeic acid		2B	
Captafol		2A	
Carbon tetrachloride		2B	2
Catechol		2B	
Ceramic Fibres (respirable size)		2B	2
Carbon-black		2B	
Carrageenan, degraded		2B	
Chlorambucil		1	1
Chloramphenicol		2A	
Chlordane		2B	
Chlordecone (Kepone)		2B	2
Chlorendic acid		2B	2
Para-Chloroaniline		2B	
Chlorinated paraffins (C12 60% Chlorine)		2B	2
α-Chlorinated toluenes		2A	
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)		2A	2
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU; Semustine)		1	1
Chloroform		2B	2
Chloromethyl methyl ether (technical-grade)	Class A	1	1
1-Chloro-2-methylpropene		2B	
3-Chloro-2-methylpropene			2
Chlorophenoxy herbicides		2B	
4-Chloro-o-phenylenediamine		2B	2
Chloroprene		2B	2
Chlorothalonil		2B	
p-Choro-o-toluidine and its strong acid salts		2A	2
Chlorozotocin		2A	2
Chromium (VI) compounds		1	1
Ciclosporin		1	
Cisplatin		2A	2
Coal-tar pitches		1	
Coal-tars		1	1

Chemical Name	MIOSHA[a]	IARC[b]	NTP[c]
Cobalt and cobalt compounds		2B	
Coffee (urinary bladder)		2B	
Conjugated estrogens			1
Creosotes		2A	1
p-Cresidine		2B	2
Cupferron			2
Cycasin		2B	
Cyclophosphamide		1	1
Cyclosporin A			1
DDT			2
Dacarbazine		2B	2
Dantron (Chrysazin; 1, 8-Dihydroxyanthraquinone)		2B	2
Daunomycin		2B	
N,N'-Diacetylbenzidine		2B	
2,4-Diaminoanisole		2B	
1,4-Diaminoanisole sulfate			2
4,4'-Diaminodiphenyl ether		2B	2
2,4-Diaminotoluene		2B	2
Dibenz[a, h]acridine		2B	2
Dibenz[a, h]anthracene		2A	2
Dibenz[a, j]acridine		2B	2
7H-Dibenzo[c,g]carbazole		2B	2
Dibenzo[a, e]pyrene		2B	2
Dibenzo[a, h]pyrene		2B	2
Dibenzo[a, i]pyrene		2B	2
Dibenzo[a, l]pyrene		2B	2
1,2-Dibromo-3-chloropropane (DBCP)	CH	2B	2
2,3-Dibromopropan-1-ol		2B	
p-Dichlorobenzene		2B	2
3,3'-Dichlorobenzidene dihydrochloride			2
3,3'-Dichlorobenzidine	Class A	2B	2
3,3'-Dichloro-4-4'-diaminodiphenyl ether		2B	
1,2-Dichloroethane		2B	2
Dichloromethane		2B	2
2-(2,4-Dichlorophenoxy)propionic acid		2B	
1,3-Dichloropropene (technical-grade)		2B	2
Dichlorvos		2B	
Diepoxybutane			2
Diesel engine exhaust particulates		2A	2
Diesel fuel, marine		2B	
Di(2-ethylhexyl) phthalate			2
1,2-Diethylhydrazine		2B	
Diethyl Sulfate		2A	2
Diethylstilbestrol (DES)		1	1
Diglycidyl resorcinol ether		2B	2
Dihydrosafrole		2B	
Diisopropyl sulfate		2B	
3,3'-Dimethoxybenzidine (o-Dianisidine)		2B	2
3,3'-Dimethoxybenzidine dihydrochloride			2
2,6-Dimethylaniline		2B	
3,3'-Dimethylbenzidine (o-Tolidine)		2B	2
1,2-Dimethylhydrazine		2A	
Dimethyl sulfate		2A	2
p-Dimethylaminoazobenzene	Class A	2B	2

Chemical Name	MIOSHA[a]	IARC[b]	NTP[c]
Trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole		2B	
Dimethylcarbamoyl Chloride		2A	2
1,1-Dimethylhydrazine		2B	2
Dimethyl vinyl chloride			2
3,7-Dinitrofluoranthene		2B	
3,9-Dinitrofluoranthene		2B	
1,6-Dinitropyrene		2B	2
1,8-Dinitropyrene		2B	2
2,4-Dinitrotoluene		2B	
2,6-Dinitrotoluene		2B	
1,4-Dioxane		2B	2
Direct Black 38			1
Direct Blue 6			1
Disperse blue 1		2B	2
Engine exhaust, gasoline		2B	
Environmental Tobacco Smoke			1
1,2-Epoxybutane		2B	
Epichlorohydrin		2A	2
Erionite		1	1
Estrogens (not conjugated) estradiol-17ß			2
Estrogens (not conjugated) estrone			2
Estrogens (not conjugated) ethinylestradiol			2
Estrogens (not conjugated) mestranol			2
Ethyl acrylate		2B	
Ethylbenzene		2B	
Ethylene thiourea		2B	2
Ethylene dibromide		2A	2
Ethylene oxide	CH	1	1
Ethyleneimine, inhibited	Class A		
Ethyl methanesulfonate		2B	2
N-Ethyl-N-nitrosourea		2A	2
Etoposide		2A	
Etoposide in combination with cisplatin and bleomycin		1	
Formaldehyde (gas)	CH	2A	2
2-(2-Formylhydrazino)-4-(5-(5-nitro-2-furyl)thiazole		2B	
Fowler's solution		1	
Fuel oil, residual		2B	
Furan		2B	2
Gasoline		2B	
Gasoline engine exhaust fumes		2B	
Gasoline, unleaded		2B	
Glass wool (respirable size)		2B	2
Glu-P-1 (2-amino-6-methyldipyrido[1, 2-a:3', 2'-d]imidazole)		2B	
Glu-P-2 (2-aminodipyrido[1, 2-a:3',2'-d]imidazole)		2B	
Glycidaldehyde		2B	
Glycidol		2A	2
Griseofulvin		2B	
HC blue 1		2B	
Heptachlor		2B	
Hexachlorobenzene		2B	2
Hexachlorocyclohexane (all isomers)		2B	2
Hexachloroethane		2B	2
Hexamethylphosphoramide		2B	2
Hydrazine (anhydrous)		2B	2

Chemical Name	MIOSHA[a]	IARC[b]	NTP[c]
Hydrazine sulfate			2
Hydrazobenzene			2
Indeno[1, 2, 3-cd]pyrene		2B	2
Inorganic-acid mists, containing sulfuric acid		1	
IQ (2-Amino-3-methylimidazo[4,5-f]quinoline)		2A	
Iron-dextran complex		2B	2
Isoprene		2B	2
Lasiocarpine		2B	
Lead and lead compounds, inorganic		2B	
Lead acetate			2
Lead phosphate			2
Lindane			2
Magenta (containing CI basic red 9)		2B	
MeA-a-C (2-Amino-3-methyl-9H-pyrido[2, 3]indole)		2B	
Medroxyprogestrone acetate		2B	
MelQ (2-Amino-3, 4-dimethylimidazol[4, 5f]quinoline		2B	
MelQx (2-AMino-3, 8-dimethylimidazo[4, 5-f]quinoxaline		2B	
Melphalan		1	1
Merphalan		2B	
5-Methoxypsoralen		2A	
8-Methoxysoralen (methoxsalen) plus ultraviolet A radiation		1	1
2-Methylaziridine (propyleneimine)		2B	2
Methylazoxymethanol acetate		2B	
5-Methylchrysene		2B	2
4,4'-Methylene bis(2-chloroaniline) (MBOCA)		2A	2
4,4'-Methylene bis(2-methylaniline)		2B	
4,4'-Methylene bis(N,N-dimethylbenzenamine)			2
4,4'-Methylenedianiline	CH	2B	2
4,4'-Methylenedianiline dihydrochloride		2B	2
Methyl Mercury Compounds		2B	
Methyl methanesulfonate		2A	2
2-Methyl-1-nitroanthraquinone (uncertain purity)		2B	
N-Methyl-N'-nitro-N-nitrosoguanidine (MNNG)		2A	2
N-Methyl-N-nitrosourea		2A	2
N-Methyl-N-nitrosourethane		2B	
Methylthiouracil		2B	
Metronidazole		2B	2
Michler's ketone [4,4'-(Dimethylamino)benzophenone]			2
Mineral oils, untreated and mildly-treated		1	1
Mirex		2B	2
Mitomycin C		2B	
Mitoxantrone		2B	
Monocrotaline		2B	
MOPP and other combined chemotherapy including alkylating agents		1	
5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone		2B	
Mustard gas		1	1
Nafenopi		2B	
α-Naphthylamine	Class A		
2-Napthylamine	Class A	1	1
Nickel compounds		1	
Nickel and certain nickel compounds			2
Nickel metallic, and alloys		2B	
Niridazole		2B	
Nitrilotriacetic acid		2B	2
Nitrilotriacetic acid and its salts		2B	

Chemical Name	MIOSHA[a]	IARC[b]	NTP[c]
5-Nitroacenaphthene		2B	
2-Nitroanisole		2B	2
Nitrobenzene		2B	
4-Nitrobiphenyl	Class A		
6-Nitrochrysene		2B	2
Nitrofen, technical-grade		2B	2
2-Nitrofluorene		2B	
1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone		2B	
N-[4-(5-Nitro-2-furyl)-2-thiaxolyl]acetamide		2B	
Nitrogen mustard		2A	
Nitrogen mustard N-oxide		2B	
Nitrogen mustard hydrochloride			2
Nitromethane		2B	
2-Nitropropane		2B	2
1-Nitropyrene		2B	2
4-Nitropyrene		2B	2
N-Nitrosodi-n-butylamine		2B	2
N-Nitrosodi-n-propylamine		2B	2
N-Nitrosodiethanolamine		2B	2
N-Nitrosodiethylamine		2A	2
N-Nitrosodimethylamine	Class A	2A	2
N-Nitroso-N-ethylurea		2A	2
3-(N-Nitrosomethylamino)propionitirile		2B	
4-(N-Nitrosomethylamino)-1-(3-pyridyl)-butanone (NNK)		2B	2
N-Nitrosomethylethylamine		2B	
N-Nitroso-N-methylurea		2A	2
N-Nitrosomethylvinylamine		2B	2
N-Nitrosomorpholine		2B	2
N-Nitrosonornicotine		2B	2
N-Nitrosopiperidine		2B	2
N-Nitrosopyrrolidine		2B	2
N-Nitrososarcosine		2B	2
Norethisterone		2B	2
Ochratoxin A		2B	2
Oestrogen-progestogen therapy, post menopausal		2B	
Oestrogen replacement therapy		1	
Oestrogen, nonsteroidal		1	
Oestrogen, steroidal		1	
Oil orange ss		2B	
Oral contraceptives, combined		1	
Oral contraceptives, sequential		1	
Oxazepan		2B	
4,4’-Oxydianiline		2B	2
Oxymetholone			2
Palygorskite (long fibers, > 5 micrometers)		2B	
Panfuran S (containing dihydorxymethylfuratrizine)		2B	
Phenacetin		2A	2
Phenazopyridine hydrochloride		2B	2
Phenobarbital		2B	
Phenolphthalein		2B	2
Phenoxybenzamine hydrochloride		2B	2
Phenyl glycidyl ether		2B	
Phenytoin		2B	2
Phlp (2-Amino-1-methyl-6-phenyl-imidazo[4,5-b]pyridine)		2B	
Piperazine estrone sulfate			1

Chemical Name	MIOSHA[a]	IARC[b]	NTP[c]
Polybrominated biphenyls		2B	2
Polychlorinated biphenyls (PCB's)		2A	2
Ponceau 3R		2B	
Ponceau MX		2B	
Potassium bromate		2B	
Procarbazine hydroxhloride		2A	2
Progesterone			2
Progestins		2B	
Progestogen-only contraceptives		2B	
1,3-Propane sultone		2B	2
β-Propiolactone	Class A	2B	2
Propyleneimine		2B	2
Propylene oxide		2B	2
Propylthiouracil		2B	2
Radon 222 and its decay products		1	1
Reserpine			2
Rockwool		2B	
Safrole		2B	2
Selenium sulfide			2
Shale-oils		1	
Silica, crystalline cristobalite (respirable size)		1	1
Silica, crystalline tridymite (respirable size)			1
Silica, crystalline quartz (respirable size)		1	1
Slagwool		2B	
Sodium equilin sulfate			1
Sodium estrone sulfate			1
Sodium ortho-phenylphenate		2B	
Soots		1	1
Sterigmatocystin		2B	
Streptozotocin		2B	2
Strong inorganic acid mists containing sulfuric acid			1
Styrene		2B	
Styrene-7,8-oxide		2A	
Sulfallate		2B	2
Talc (containing asbestos fibers)		1	
Tamoxifen		1	1
Tars			1
Teniposide		2A	
2,3,7,8-Tetrachlorodibenzo-para-dioxin (TCDD)		1	1
Tetrachloroethylene		2A	2
Tetrafluoroethylene		2B	2
Tetranitromethane		2B	2
Thioacetamide		2B	2
4,4'-Thiodianiline		2B	
Thiotepa		1	1
Thiourea		2B	2
Thorium dioxide			1
Tobacco products, smokeless		1	1
Tobacco smoke		1	1
o-Tolidine		2B	2
Toluene diisocyanates		2B	2
o-Toluidine		2A	2
o-Toluidine hydrochloride			2
Toxaphene (Polychlorinated camphenes)		2B	2
Treosulfan		1	

Chemical Name	MIOSHA[a]	IARC[b]	NTP[c]
Trichlormethine (trimustine hydrochloride)		2B	
Trichloroethylene		2A	2
2,4,6-Trichlorophenol			2
1,2,3-Trichloropropane		2A	2
Tris (2,3-dibromopropyl)phosphate		2A	2
Trp-P-1 (3-Amino-1,4-dimethyl-5H-pyrido[4,3-b] indole)		2B	
Trp-P-2 (3-Amino-1-methyl-5H-pyrido[4,3-b]indole)		2B	
Trypan blue		2B	
Uracil mustard		2B	
Urethane		2B	
Vinyl acetate		2B	2
Vinyl bromide		2A	
Vinyl chloride	CSA	1	1
4-Vinyl cyclohexene		2B	
4-Vinyl-1-cyclohexene diepoxide			2
4-Vinylcyclohexene diepoxide		2B	
Vinyl fluoride		2A	
Welding Fumes		2B	
2,6-Xylidine (2,6-Dimethylaniline)		2B	
Zalcitabine		2B	
Zidovidine		2B	

(a) Michigan Occupationas Safety and Health Administration (MIOSHA):
Class A: Regulated as a known human carcinogen
CSA: listed as a Cancer Suspect Agent
CH: listed as a Cancer Hazard

(b) International Agency for Research on Cancer (IARC):
1. Carcinogenic to humans with sufficient epidemiological evidence
2A. Probably carcinogenic to humans with (usually) at least limited human evidence
2B. Probably carcinogenic to humans, but having (usually) no human evidence
For a complete listing of IARC carcinogens, mixtures and exposure circumstances, see www.iarc.fr

© National Toxicology Program (NTP):
a. Known to be carcinogenic with evidence from human studies
b. Reasonably anticipated to be a carcinogen, with limited evidence in humans or sufficient evidence in experimental animals
More information on NTP carcinogens can be found at: http://ntp-server.niehs.nih.gov

APPENDIX C
INCOMPATIBILITY OF COMMON LABORATORY CHEMICALS

When certain hazardous chemicals are stored or mixed together, violent reactions may occur because the chemicals are unsuitable for mixing, or are *incompatible*. Classes of incompatible chemicals should be segregated from each other during storage, according to hazard class. Use the following general guidelines for hazard class storage:

- Flammable/Combustible Liquids and Organic Acids
- Flammable Solids
- Mineral Acids
- Caustics
- Oxidizers
- Perchloric Acid
- Compressed Gases

Before mixing any chemicals, refer to this partial list, the chemicals' SDS's to verify compatibility:

CHEMICAL	INCOMPATIBLE CHEMICAL(S)
Acetic acid	aldehyde, bases, carbonates, hydroxides, metals, oxidizers, peroxides, phosphates, xylene
Acetylene	halogens (chlorine, fluorine, etc.), mercury, potassium, oxidizers, silver
Acetone	acids, amines, oxidizers, plastics
Alkali and alkaline earth metals	acids, chromium, ethylene, halogens, hydrogen, mercury, nitrogen, oxidizers, plastics, sodium chloride, sulfur
Ammonia	acids, aldehydes, amides, halogens, heavy metals, oxidizers, plastics, sulfur
Ammonium nitrate	acids, alkalis, chloride salts, combustible materials, metals, organic materials, phosphorous, reducing agents, urea
Aniline	acids, aluminum, dibenzoyl peroxide, oxidizers, plastics
Azides	acids, heavy metals, oxidizers
Bromine	acetaldehyde, alcohol's, alkalis, amines, combustible materials, ethylene, fluorine, hydrogen, ketones (acetone, carbonyls, etc.), metals, sulfur
Calcium oxide	acids, ethanol, fluorine, organic materials
Carbon (activated)	alkali metals, calcium hypochlorite, halogens, oxidizers
Carbon tetrachloride	benzoyl peroxide, ethylene, fluorine, metals, oxygen, plastics, silanes
Chlorates	powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid	acetone, alcohol's, alkalis, ammonia, bases,
Chromium trioxide	benzene, combustible materials, hydrocarbons, metals, organic materials, phosphorous, plastics
Chlorine	alcohol's, ammonia, benzene, combustible materials, flammable compounds (hydrazine), hydrocarbons (acetylene, ethylene, etc.), hydrogen peroxide, iodine, metals, nitrogen, oxygen, sodium hydroxide
Chlorine dioxide	hydrogen, mercury, organic materials, phosphorous, potassium hydroxide, sulfur
Copper	calcium, hydrocarbons, oxidizers
Hydroperoxide	reducing agents
Cyanides	acids, alkaloids, aluminum, iodine, oxidizers, strong bases
Flammable liquids	ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	alcohol's, aldehydes, ammonia, combustible materials, halocarbons, halogens, hydrocarbons, ketones, metals, organic acids
Hydrocarbons (Such as butane, propane benzene, turpentine, etc.)	acids, bases, oxidizers, plastics
Hydrofluoric acid	metals, organic materials, plastics, silica (glass)

CHEMICAL	INCOMPATIBLE CHEMICAL(S)

Hydrogen peroxide	acetylaldehyde, acetic acid, acetone, alcohol's carboxylic acid, combustible materials, metals, nitric acid, organic compounds, phosphorous, sulfuric acid, sodium, aniline
Hydrogen sulfide	acetylaldehyde, metals, oxidizers, sodium
Hypochlorites	acids, activated carbon
Iodine	acetylaldehyde, acetylene, ammonia, metals, sodium
Mercury	acetylene, aluminum, amines, ammonia, calcium, fulminic acid, lithium, oxidizers, sodium
Nitrates	acids, nitrites, metals, sulfur, sulfuric acid
Nitric acid	acetic acid, acetonitrile, alcohol's, amines, (concentrated) ammonia, aniline, bases, benzene, cumene, formic acid, ketones, metals, organic materials, plastics, sodium, toluene
Oxalic acid	oxidizers, silver, sodium chlorite
Oxygen	acetaldehyde, secondary alcohol's, alkalis and alkalines, ammonia, carbon monoxide, combustible materials, ethers, flammable materials, hydrocarbons, metals, phosphorous, polymers
Perchloric acid	acetic acid, alcohol's, aniline, combustible materials, dehydrating agents, ethyl benzene, hydriotic acid, hydrochloric acid, iodides, ketones, organic material, oxidizers, pyridine
Peroxides, organic	acids (organic or mineral)
Phosphorus (white)	oxygen (pure and in air), alkalis
Potassium	acetylene, acids, alcohol's, halogens, hydrazine, mercury, oxidizers, selenium, sulfur
Potassium chlorate	acids, ammonia, combustible materials, fluorine, hydrocarbons, metals, organic materials, sugars
Potassium perchlorate	alcohol's, combustible materials, fluorine, hydrazine, metals, (also see chlorates)organic matter, reducing agents, sulfuric acid
Potassium permanganate	benzaldehyde, ethylene glycol, glycerol, sulfuric acid
Silver	acetylene, ammonia, oxidizers, ozonides, peroxyformic acid
Sodium	acids, hydrazine, metals, oxidizers, water
Sodium nitrate	acetic anhydride, acids, metals, organic matter, peroxyformic acid, reducing agents
Sodium peroxide	acetic acid, benzene, hydrogen sulfide metals, oxidizers, peroxyformic acid, phosphorous, reducers, sugars, water
Sulfides	acids
Sulfuric acid	potassium chlorates, potassium perchlorate, potassium permanganate

References: Safety data sheets, various chemical companies

APPENDIX D

COMMON LABORATORY FLAMMABLE AND COMBUSTIBLE CHEMICALS

Flammable and combustible chemicals are the most commonly used hazardous chemicals. The hazard of a flammable or combustible chemical is based on its flash point, and, in the case of a flammable chemical, its boiling point as well. The National Fire Protection Association (NFPA) has identified flammability classes from the flash point and boiling point data of chemicals. The following table lists some common flammable and combustible chemicals, their flash points and boiling points, and associated NFPA flammability classes:

Chemical	Flash Point		Boiling Point		NFPA Class
	°F	°C	°F	°C	
Acetaldehyde	-38	-39	69	21	IA
Dimethyl sulfide	-36	-38	99	37	IA
Ethyl ether	-49	-45	95	35	IA
Ethylene oxide	-20	-29	55	13	IA
Pentane	-57	-49	97	36	IA
Propane	157	105	-44	-42	IA
Benzene	12	-11	176	80	IB
Carbon disulfide	-22	-30	115	46	IB
Cyclohexane	-4	-20	179	81	IB
Ethyl alcohol	55	13	173	78	IB
n-Hexane	-7	-22	156	69	IB
Isopropyl alcohol	53	12	180	82	IB
Methyl alcohol	52	11	149	65	IB
Methyl ethyl ketone	16	-9	176	80	IB
Pyridine	68	20	239-241	116	IB
Tetrahydrofuran	6	-14	153	67	IB
Toluene	40	4	231	111	IB
Triethylamine	20	-7	193	89	IB
tert Butyl isocyanate	80	27	185-187	85-86	IC
Chlorobenzene	82	28	270	132	IC
Epichlorohydrin	88	31	239-243	115-117	IC
2-Nitropropane	75	24	248	120	IC
Xylene	81-90	27-32	280-291	138-144	IC
Acetic Acid, glacial	103	39	244	48	II
Bromobenzene	118	48	307-316	153-158	II
Formic Acid	156	69	213	101	II
Morpholine	100	38	263	128	II
Stoddard Solvent	100-140	38-60	300-400	150-200	II
Benzaldehyde	145	63	352	178	IIIA
Cyclohexanol	154	68	322	161	IIIA
Methacrylic Acid	170	77	316	158	IIIA
Nitrobenzene	190	88	412	211	IIIA
Tetrahydronaphthalene	160	71	406	208	IIIA
Benzyl Alcohol	213	101	401	205	IIIB
Caproic Acid	215	102	400	204	IIIB
Ethylene Glycol	232	111	388	198	IIIB
Phenyl Ether	239	115	498	258	IIIB
Stearic Acid	385	196	726	386	IIIB

References: Material Safety Data Sheets and the National Fire Protection Agency document "NFPA 321: Classification of Flammable and Combustible Liquids, 1991 Edition."

APPENDIX E

Flammable Liquid Storage Limits for Laboratories

Maximum Quantities of Flammable and Combustible Liquids in Sprinklered Laboratory Units Outside of Flammable Liquid Inside Liquid Storage Areas

		Excluding Quantities in Storage Cabinets or Safety Cans		Including Quantities in Storage Cabinets or Safety Cans	
Laboratory Unit Fire Hazard Class	Flammable or Combustible Liquid Class	Maximum Quantity per 100 ft^2 of Laboratory Unit (gals)	Maximum Quantity per Laboratory Unit (gals)	Maximum Quantity per 100 ft^2 of Laboratory Unit (gals)	Maximum Quantity per Laboratory Unit (gals)
A	I	10	600	20	1200
	I, II, IIIA	20	800	40	1600
B	I	5	300	10	600
	I, II, IIIA I	10	400	20	800
C	I	2	150	4	300
	I, II, IIIA I	4	200	8	400
D	I	1.1	75	2	150
	I, II, IIIA I	1.1	75	2	150

Maximum Quantities of Flammable and Combustible Liquids in Nonsprinklered Laboratory Units Outside of Flammable Liquid Inside Liquid Storage Areas

		Excluding Quantities in Storage Cabinets or Safety Cans		Including Quantities in Storage Cabinets or Safety Cans	
Laboratory Unit Fire Hazard Class	Flammable or Combustible Liquid Class	Maximum Quantity per 100 ft^2 of Laboratory Unit (gals)	Maximum Quantity per Laboratory Unit (gals)	Maximum Quantity per 100 ft^2 of Laboratory Unit (gals)	Maximum Quantity per Laboratory Unit (gals)
A	I	10	300	20	600
	I, II, IIIA	20	400	40	800
B	I	5	150	10	300
	I, II, IIIA I	10	200	20	400
C	I	2	75	4	150
	I, II, IIIA I	4	100	8	200
D	I	1.1	37	2	75
	I, II, IIIA I	1.1	37	2	75

Laboratories listed as Class A shall be considered high hazard laboratories and shall not be used as instructional laboratories.

Laboratories listed as Class B shall be considered intermediate hazard laboratories.

Laboratories listed as Class C shall be considered low hazard laboratories.

Laboratories listed as Class D shall be considered minimal fire hazard laboratories.

Flammable Liquid Container Size Limits

Only approved containers authorized by NFPA (National Fire Protection Association) 30 shall be used to store flammable liquids.

	Flammable Class			Combustible Class	
Container	**IA**	**IB**	**IC**	**II**	**III**
Glass	1 pt*	1 qt*	1.1 gal	1.1 gal	5 gal
Metal or Approved Plastic	1.1 gal	5 gal	5 gal	5 gal	5 gal
Safety Cans	2.6 gal	5 gal	5 gal	5 gal	5 gal
Metal Drums	not allowed	5 gal	5 gal	60 gal	60 gal
Polyethylene	1.1 gal	5 gal	5 gal	60 gal	60 gal

*Class IA and IB liquids may be stored up to one gallon in glass containers if liquid purity would be affected by storage in metal containers or if metal containers could undergo excessive corrosion by the contained liquid.

APPENDIX F

COMMON LABORATORY CORROSIVES

ORGANIC ACIDS

Formic Acid
Acetic Acid (Glacial)
Propionic Acid
Butyric Acid
Chloroacetic Acid
Trichloroacetic Acid
Acetyl Chloride
Acetyl Bromide
Chloroacetyl Chloride
Oxalic Acid
Propionyl Chloride
Propionyl Bromide
Acetic Anhydride
Methyl Chloroformate
Dimethyl Sulfate
Chlorotrimethylsilane
Dichlorodimethylsilane
Phenol
Benzoyl Chloride
Benzoyl Bromide
Benzyl Chloride
Benzyl Bromide
Salicylic Acid

ORGANIC BASES

Ethylenediamine
Ethylimine
Tetramethylethylenediamine
Hexamethylenediamine
Trimethylamine aq. soln.
Triethylamine
Phenylhydrazine
Piperazine
Hydroxylamine
Tetramethylammonium Hydroxide

ELEMENTS

Fluorine (gas)
Chlorine (gas)
Bromine (liquid)
Iodine (crystal)
Phosphorus

INORGANIC BASES

Ammonium Hydroxide
Calcium Hydroxide
Sodium Hydroxide
Potassium Hydroxide
Calcium Hydride
Sodium Hydride
Hydrazine
Ammonium Sulfide
Calcium Oxide

INORGANIC ACIDS

Hydrofluoric Acid
Hydrochloric Acid
Hydrobromic Acid
Hydriodic Acid
Sulfuric Acid
Chromerge™
No-Chromix™
Chlorosulfonic Acid
Sulfuryl Chloride
Bromine Pentafluoride
Thionyl Chloride
Tin Chloride
Tin Bromide
Titanium Tetrachloride
Perchloric Acid
Nitric Acid
Phosphoric Acid
Phosphorus Trichloride
Phosphorus Tribromide
Phosphorus Pentachloride
Phosphorus Pentoxide

ACID SALTS

Aluminum Trichloride
Antimony Trichloride
Ammonium Bifluoride
Calcium Fluoride
Ferric Chloride
Sodium Bisulfate
Sodium Fluoride

References :
The Foundations of Laboratory Safety, S.. R. Rayburn, 1990.
Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Research Council, 1981.
Improving Safety in the Chemical Laboratory, 2nd Ed., J. A. Young, 1991.
Safety data sheets, various chemical companies.

APPENDIX G

COMMON LABORATORY OXIDIZERS

Oxidizers react with other chemicals by giving off electrons and undergoing reduction. Uncontrolled reactions of oxidizers may result in a fire or an explosion, causing severe property damage or personal injury. Use oxidizers with extreme care and caution and follow all safe handling guidelines specified in the SDS.

Bleach
Bromates
Bromine
Butadiene
Chlorates
Chloric Acid
Chlorine
Chlorite
Chromates
Chromic Acid
Dichromates
Fluorine
Haloate
Halogens
Hydrogen Peroxide
Hypochlorites
Iodates
Mineral Acid
Nitrates
Nitric Acid
Nitrites
Nitrous oxide
Ozanates
Oxides
Oxygen
Oxygen difluoride
Ozone
Peracetic Acid
Perhaloate
Perborates
Percarbonates
Perchlorates
Perchloric Acid
Permanganates
Peroxides
Persulfate
Sodium Borate Perhydrate
Sulfuric Acid

Classes of Peroxidizable Chemicals

A. Chemicals that form explosive levels of peroxides without concentration

Butadiene[a]
Chloroprene[a]
Divinylacetylene
Isopropyl ether
Tetrafluoroethylene[a]
Vinylidene chloride

B. Chemicals that form explosive levels of peroxides on concentration

Acetal
Acetaldehyde
Benzyl alcohol
2-Butanol
Cumene
Cyclohexanol
2-Cyclohexen-1-ol
Cyclohexene
Decahydronaphthalene
Diacetylene
Dicyclopentadiene
Diethyl ether
Diethylene glycol dimethyl ether (diglyme)
Dioxanes
Ethylene glycol dimethyl ether (glyme)
4-Heptanol
2-Hexanol
Methylacetylene
3-Methyl-1-butanol
Methylcyclopentane
Methyl isobutyl ketone
4-Methyl-2-pentanol
2-Penten-1-ol
4-Penten-1-ol
1-Phenylethanol
2-Hexanol
Methylacetylene
3-Methyl-1-butanol
Methylcyclopentane
Methyl isobutyl ketone
4-Methyl-2-pentanol

C. Chemicals that may autopolymerize as a result of peroxide accumulation

Acrylic acid[b]
Acrylonitrile[b]
Butadiene[c]
Chloroprene[c]
Chlorotrifluoroethylene
Methyl methacrylate[b]
Styrene
Tetrafluoroethylene[c]
Vinyl acetate
Vinylacetylene
Vinyl chloride
Vinylpyridine
Vinyladiene chloride

D. Chemicals that may form peroxides but cannot clearly be placed in sections A-C

Acrolein
Allyl ether[d]
Allyl ethyl ether
Allyl phenyl ether
p-(n-Amyloxy)benzoyl chloride
n-Amyl ether
Benzyl n-butyl ether[d]
Benzyl ether[d]
Benzyl ethyl ether[d]
Benzyl methyl ether
Benzyl 1-naphthyl ether[d]
1,2-Bis(2-chloroethoxy)ethane
Bis(2-ethoxyethyl) ether
Bis(2-(methoxyethoxy)ethyl) ether
Bis(2-chloroethyl) ether
Bis(2-ethoxyethyl) adipate
p-Dibenzyloxybenzene[d]
1,2-Dichloroethyl ethyl ether
2,4-Dichlorophenetole
Diethoxymethane[d]
2,2-Diethoxypropane
Diethyl ethoxymethylenemalonate
Diethyl fumarate[d]
Diethyl acetal[d]
Diethylketene[f]
m,o,p-Diethoxybenzene
1,2-Diethoxyethane
Dimethoxymethane[d]
1,1-Dimethoxyethane[d]
Dimethylketene[f]
3,3-Dimethoxypropene
2,4-Dinitrophenetole
1,3-Dioxepane[d]
4-Methyl-2-pentanone
n-Methylphenetole
2-Methyltetrahydrofuran
3-Methoxy-1-butyl acetate
2-Methoxyethanol
3-Methoxyethyl acetate
2-Methoxyethyl vinyl ether
Methoxy-1,3,5,7-cycloocta tetraene
ß-Methoxypropionitrile
m-Nitrophenetole
1-Octene
Oxybis(2-ethyl acetate)
Oxybis(2-ethyl benzoate)
ß,ß-Oxydipropionitrile
1-Pentene
Phenoxyacetyl chloride

Table D Continued

D. Chemicals that may form peroxides but cannot clearly be placed in sections A-C

Bis(2-ethoxyethyl) phthalate
Bis(2-methoxyethyl)carbonate
Bis(2-methoxyethyl) ether
Bis(2-methoxyethyl)phthalate
Bis(2-methoxymethyl) adipate
Bis(2-n-butoxyethyl) phthalate
Bis(2-phenoxyethyl) ether
Bis(4-chlorobutyl) ether
Bis(chloromethyl) ether[e]
2-Bromomethyl ethyl ether
ß-Bromophenetole
o-Bromophenetole
p-Bromophenetole
3-Bromopropyl phenyl ether
1,3-Butadiyne
Buten-3-yne
tert-Butyl ethyl ether
tert-Butyl methyl ether
n-Butyl phenyl ether
n-Butyl vinyl ether
Chloroacetaldehyde diethylacetal[d]
2-Chlorobutadiene
1-(2-Chloroethoxy)-2-phen-oxyethane
Chloroethylene
Chloromethyl methyl ether[e]
ß-Chlorophenetole
o-Chlorophenetole
p-Chlorophenetole
Cyclooctene[d]
Cyclopropyl methyl ether
Diallyl ether[d]
p-Di-n-butoxybenzene
1,2-Dibenzyloxyethane[d]
Di(1-propynyl) ether[f]
Di(2-propynyl) ether
Di-n-propoxymethane[d]
1,2-Epoxy-3-isopropoxypropane[d]
1,2-Epoxy-3-phenoxypropane
Ethoxyacetophenone
1-(2-Ethoxyethoxy)ethyl acetate
2-Ethoxyethyl acetate
(2-Ethoxyethyl)-o-benzoyl benzoate
1-Ethoxynaphthalene
o,p-Ethoxyphenyl isocyanate
1-Ethoxy-2-propyne
3-Ethoxyopropionitrile
2-Ethylacrylaldehyde oxime
2-Ethylbutanol
Ethyl ß-ethoxypropionate
2-Ethylhexanal
Ethyl vinyl ether
Furan
2,5-Hexadiyn-1-ol
4,5-Hexadien-2-yn-1-ol
n-Hexyl ether
o,p-Iodophenetole
Isoamyl benzyl ether[d]
Isoamyl ether[d]
Isobutyl vinyl ether
Isophorone[d]
p-Isopropoxypropionitrile[d]
Isopropyl 2,4,5-trichlorophenoxy-acetate
Limonene
1,5-p-Methadiene
Methyl p-(n-amyloxy)benzoate
å-Phenoxypropionyl chloride
Phenyl o-propyl ether
p-Phenylphenetone
n-Propylether
n-Propyl isopropyl ether
Sodium 8,11,14-eicosa tetraenoate
Sodium ethoxyacetylide[f]
Tetrahydropyran
Triethylene glycol diacetate
Triethylene glycol dipropionate
1,3,3-Trimethoxypropene[d]
1,1,2,3-Tetrachloro-1,3-butadiene
4-Vinyl cyclohexene
Vinylenecarbonate
Vinylidene chioride[d]

[a] When stored as a liquid monomer
[b] Although these chemicals form peroxides, no explosions involving these monomers
[c] When stored in liquid form, these chemicals form explosive levels of peroxides without concentration. They may also be stored as a gas
in gas cylinders. When stored as a gas, these chemicals may autopolymerize as a result of peroxide accumulation.
[d] These chemicals easily form peroxides and should probably be considered under part B.
[e] OSHA-regulated carcinogen
[f] Extremely reactive and unstable compound.

Safe Storage Period for Peroxide Forming Chemicals

Description	Period
Unopened chemicals from manufacturer	18 months
Opened containers	
Chemicals in Part A	3 months
Chemicals in Parts B and D	12 months
Unihibited chemicals in Part C	24 hours
Inhibited chemicals in Part C	12 months[a]

[a] Do not store under inert atmosphere, oxygen required for inhibitor to function.

Sources: Kelly, Richard J., Chemical Health & Safety, American Chemical Society, **1996,** Sept, 28-36

Revised 12/97

DETECTION AND INHIBITION OF PEROXIDES
BASIC PROTOCOLS

Ferrous Thiocyanate Detection Method

Ferrous thiocyanate will detect hydroperoxides with the following test:

1. Mix a solution of 5 ml of 1% ferrous ammonium sulfate, 0.5 ml of 1N sulfuric acid and 0.5 ml of 0.1N ammonium thiocyanate (if necessary decolorize with a trace of zinc dust)

2. Shake with an equal quantity of the solvent to be tested

3. If peroxides are present, a red color will develop

Potassium Iodide Detection Method

1. Add 1 ml of a freshly prepared 10% solution of potassium iodide to 10 ml of ethyl ether in a 25 ml glass-stoppered cylinder of colorless glass protected from light (both components are clear)
2. A resulting yellow color indicates the presence of 0.005% peroxides

Inhibition of Peroxides

1. Storage and handling under an inert atmosphere is a useful precaution

2. Addition of 0.001% hydroquinone, diphenylamine, polyhydroxyphenols, aminophenols or arylamines may stabilize ethers and inhibit formation of peroxides.

3. Dowex-1® has been reported effective for inhibiting peroxide formation in ethyl ether.

4. 100 ppm of 1-naphthol effective for peroxide inhibition in isopropyl ether.

5. Hydroquinone effective for peroxide inhibition in tetrahydrofuran.

6. Stannous chloride or ferrous sulfate effective for peroxide inhibition in dioxane.

Peroxides Test Strips

These test strips are available from EM Scientific, cat. No. 10011-1 or from Lab Safety Supply, cat. No. 1162. These strips quantify peroxides up to a concentration of 25 ppm. Aldrich Chemical has a peroxide test strip, cat. No. Z10,168-0, that measures up to 100 ppm peroxide. The actual concentration at which peroxides become hazardous is not specifically stated in the literature. A number of publications use 100 ppm as a control value for managing the material safely.

Please note that these methods are BASIC protocols. Should a researcher perform one of these methods, all safety precautions should be thoroughly researched.

Sources:
1. Furr, Keith Handbook of Lab Safety, 4th ed., CRC Press, 1995
2. Kelly, Richard J., Review of Safety Guidelines for Peroxidizable Organic Chemicals, Chemical Health & Safety, American Chemical Society, Sept./Oct 1996

APPENDIX I

SHOCK SENSITIVE AND EXPLOSIVE CHEMICALS

Shock sensitive refers to the susceptibility of a chemical to rapidly decompose or explode when struck, vibrated or otherwise agitated. Explosive chemicals are those chemicals which have a higher propensity to explode under a given set of circumstances than other chemicals (extreme heat, pressure, mixture with an incompatible chemical, etc.). The label and SDS will indicate if a chemical is shock sensitive or explosive . The chemicals listed below may be shock sensitive or explode under a given number of circumstances and are listed only as a guide to **some** shock sensitive or explosive chemicals. Follow these guidelines:

- Write the date received and date opened on all containers of shock sensitive chemicals. Some chemicals become increasingly shock sensitive with age.
- Unless an inhibitor was added by the manufacturer, closed containers of shock sensitive materials should be discarded after 1 year.
- Wear appropriate personal protective equipment when handling shock sensitive chemicals.

acetylene
acetylides of heavy metal
amatex
amatol
ammonal
ammonium nitrate
ammonium perchlorate
ammonium picrate
azides of heavy metals
baratol
calcium nitrate
chlorate
copper acetylide
cyanuric triazide
cyclotrimethylenetrinitramine
dinitrophenol
dinitrophenyl hydrazine
dinitrotoluene
ednatol
erythritol tetranitrate
fulminate of mercury
fulminate of silver
ethylene oxide
ethyl-tetryl
fulminating gold
fulminating mercury
fulminating platinum
fulminating silver
gelatinized nitrocellulose
guanyl
guanyl nitrsamino
guanyltetrazene
hydrazine
nitrated carbohydrate
nitrated glucoside
nitrogen triiodide
nitrogen trichloride
nitroglycerin
nitroglycide
nitroglycol
nitroguanidine
nitroparaffins
nitrourea
organic nitramines
ozonides
pentolite
perchlorates of heavy metals
peroxides
picramic acid
picramide
picratol
picric acid
picryl sulphonic acid
silver acetylide
silver azide
tetranitromethane

Mixtures:

germanium
hexanitrodiphenyamine
hexanitrostilbene
hexogen
hydrazoic acid
lead azide
lead mononitroresorcinate
lead styphnate
mannitol hexanitrate
sodium picramate
tetranitrocarbazole
tetracene
tetrytol
trimethylolethane
trimonite
trinitroanisole
trinitrobenzene
trinitrobenzoic acid
trinitrocresol
trinitroresorcinol
tritonal
urea nitrate

References: Safety data sheets, various chemical companies

APPENDIX J

Standard Operating Procedure for Clean-Up of Small Blood Spills

Follow these procedures for cleaning up spills of blood and blood products. The same procedures can be used for cleaning up other body fluids.

Contact the lab director and/or lab safety officer of every incident that results in the release of blood or blood products.

Required Personal Protective Equipment.

1.1 Prior to beginning the clean-up, put on a pair of rubber, latex, PVC or similar type gloves.

1.2 For small blood spills no other PPE should be required. For larger spills where there is a possibility of contaminating your face or other body parts, the lab director of safety officer will contact an outside party to perform the clean-up.

1.3 Spill kit Equipment
The following item may be needed in handling the spill:

- 10% bleach solution (or any EPA approved Tubercalocidal)
- Gloves
- Clear plastic bags or labels, if bags not available.
- Leak proof approved sharps container.
- Brush and dustpan, or tongs or forceps for picking up sharps.
- Disinfectant wipes.

These kits should be inspected quarterly, as part of the LESS quarterly safety inspection to ensure completeness.

1.4 There should be one kit in the spectroscopy lab (Room 111), one kit in the Chromatography lab (Room 109), and one kit in ICM (Room 113).

2. Spill Decontamination Procedures

2.1 Cover the spill area with a paper towel and then pour freshly mixed 10% bleach and water solution, or equivalent onto the affected area.

2.2 Any glass, needles or other sharp objects that may cause a cut will not be picked up by hand. Only mechanical means such as a brush and dustpan, tongs or forceps are allowed to come into contact with the sharps.

2.3 Allow the solution to soak into the contaminated material. Work from the outside edges of the spill inward when applying the bleach solution.

2.4 Wipe up bleached material with paper towels or absorbent pads. It may be necessary to use a scrub brush to remove the material if it impacted a hard porous surface such as concrete.

2.5 If porous surfaces, such a carpet, have been contaminated, an outside vendor may be needed to clean the area.

3. Disposal

3.1 Place bleached materials, gloves and other disposable materials into a labeled biohazard bag.
3.2 Place all sharps into an approved sharps container.
3.3 Ensure lids are firmly sealed on all waste containers when spill clean-up is complete.
3.4 Keep all biohazard waste containers in a secured area until pickup.
3.5 Call DMB 2-1499 to arrange for a waste pickup.
3.6 Prepare a detailed report of the incident and forward to the lab director and safety officer.
3.7 Inventory the spill kits that were used and reorder any supplies that were exhausted.

4. Decontamination of Re-usable Equipment

4.1 Decontaminate, with the bleach solution, all potentially contaminated re-usable tools or protective equipment used it the cleanup. This includes dustpans, brooms, forceps, buckets, etc.
4.2 Anything that cannot be effectively cleaned (bleach solution must be able to make contact with all surfaces) must be disposed as waste.
4.3 After the contaminated area has been cleaned, use fresh water to remove bleach residue from all surfaces.

5. Personal Hygiene

1.1 Wash your hands immediately after removing gloves.
1.2 If you believe you were exposed (skin puncture or splash to eyes or mucous membranes) to biohazard material that had not been decontaminated with bleach solution follow these recommended steps:

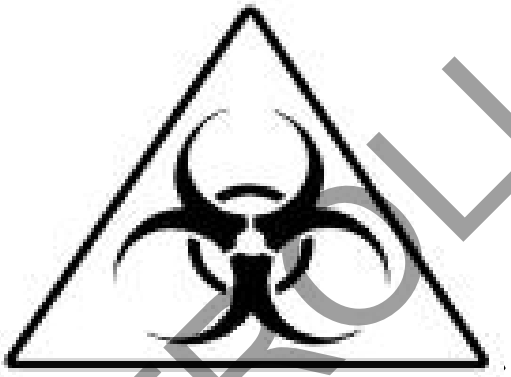
- Skin exposure: Vigorously wash affected skin with plenty of soap and water while removing contaminated clothes and shoes. If open lesions or wounds have been in contact with biohazard materials a skin disinfectant (70% alcohol, Beta dine, etc) should be applied after washes.
- Eye exposure: Wash eyes for at least 10 minutes with copious amounts of water, lifting the upper and lower eyelids occasionally.
- Seek follow up medical attention by contacting the lab director for referral to the state's medical services.
- If in mouth, rinse mouth for 2-3 minutes with water.

APPENDIX K

MICHIGAN OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

EMERGENCY RESPONSE TEAM

EXPOSURE CONTROL PLAN



Date of Preparation: June 10, 1993

Revision Dates:
September 21, 2012
August, 2010
June, 2009
February, 2008
August, 2006
December, 2005
December, 2004
March, 2003
December 30, 2002
April 05, 2000
April 17, 1998
January 13, 1997

Coordinators:
Cindy Zastrow, CSHD
Shellene Boyd, MMWHTSD
Sherry Scott, CETD

Emergency Response Team

To the extent possible, the team has one member from each MIOSHA division and each field office.

General Office Bldg.- Lansing

- Administration & MWHTSD
  Bogle, Ray
  Boyd, Shellene
  Parrish, Heather
  Pickelman, Barton
- CET Division
  Meddaugh, Jodi
  Scott, Sherry
- Construction Safety & Health Division
  Zastrow, Cindy
- General Industry Safety & Health Division
  Haeck, Leanne
- Wage and Hour Division
  Jason Koontz

Field Offices:

- Grand Rapids
  MacFarlane, Scott
  Nichols, Keith
- Saginaw
  Vacant
- Lab
  Almanza, David
  Isenga, Dave

Emergency Response Team First-Aid/CPR/AED Training

The MIOSHA Emergency Response Team will be provided with American Red Cross first-aid, CPR, and AED training twice per year by an in-house and/or contracted American Red Cross certified instructor.

EXPOSURE DETERMINATION

Pursuant to agency policy BA-BSRERT-1, an Emergency Response Team (ERT) is established within the Michigan Occupational Safety and Health Administration (MIOSHA) to assist in responding to medical emergencies for personnel located in MIOSHA offices. The Agency Director, from among MIOSHA employee volunteers, will appoint the emergency response team. To the extent possible, the team shall have one member from each MIOSHA division.

It is our intent to provide appropriate (cardiopulmonary resuscitation and/or first-aid), immediate assistance during the first few minutes before medical help arrives, by establishing an emergency response team and providing training and protections of a medical emergency for team members.

The members of the emergency response team may have exposure to bloodborne

pathogens when they perform CPR/first-aid in the course of their volunteer duties as ERT members. The emergency response team will be considered "Category A" as defined in the Michigan Part 554, Bloodborne Infectious Diseases Standard (R 325.70001 et seq.).

COMPLIANCE METHODS/STANDARD OPERATING PROCEDURES

Universal precautions will be observed by all ERT members at all times while providing CPR and/or first-aid in order to prevent contact with blood or other potentially infectious material (OPIM). Other potentially infectious materials include the following:

a) Semen.
b) Vaginal secretions.
c) Amniotic fluid.
d) Cerebrospinal fluid.
e) Peritoneal fluid.
f) Pleural fluid.
g) Pericardial fluid.
h) Synovial fluid.
i) Saliva in dental procedures.
j) Any body fluid that is visibly contaminated with blood or OPIM.
k) All body fluids in situations where it is difficult or impossible to differentiate between body fluids.

All blood and OPIM will be considered infectious regardless of the perceived status of the source individual.

Urine, feces, and vomit are not considered OPIM except in cases (J) or (K) above.

ENGINEERING CONTROLS AND WORK PRACTICES

Engineering controls were not deemed applicable for the anticipated exposure potential of ERT members. Work practice controls are limited to hand washing and housekeeping practices. Where blunt-tipped scissors or other non-disposable items are used in a first-aid/CPR procedure and they become contaminated, employees will be instructed and trained to properly decontaminate the equipment using an appropriate EPA List B registered disinfectant (tuberculocide).

Hand washing facilities are available to the employees who incur exposure to blood or other potentially infectious materials. MIOSHA requires that these facilities be readily accessible after incurring exposure. Within all MIOSHA office settings, hand-washing facilities are available on every floor of every building. After removal of personal protective gloves, employees shall wash hands and any other potentially contaminated skin area immediately or as soon as feasible with soap and water.

If employees incur exposure to their skin or mucous membranes, then those areas shall be washed or flushed with water as appropriate as soon as feasible following contact.

NEEDLES AND SHARPS

Needle use and handling is prohibited. Sharp use and handling is prohibited. The agency policy is to provide blunt-tipped scissors in each first-aid kit, which may be used to cut a piece of clothing or bandage.

WORK AREA RESTRICTIONS

All incidents will be of an emergency nature and can occur at any location in a MIOSHA office.

In accordance with MIOSHA Administration and OHR policy, employees shall not take another employee to the hospital in their personal vehicle. The affected employee must be transported by a friend, family member or ambulance.

PERSONAL PROTECTIVE EQUIPMENT/STANDARD OPERATING PROCEDURES

All personal protective equipment used by ERT members will be provided without cost to employees. Personal protective equipment will be chosen based on the anticipated exposure to blood or other potentially infectious materials. The protective equipment will be considered appropriate only if it does not permit blood or other potentially infectious materials to pass through or reach the employees' clothing, skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time which the protective equipment will be used.

The following PPE is used by ERT members:

Personal Protective Equipment	Task
Gloves	First-Aid, CPR
One-way resuscitation shields/masks	CPR

Gloves shall be worn during all procedures. Shields shall be used in all CPR procedures. All members of the ERT shall have their own personal CPR shield and supply of gloves. Each first-aid kit in the agency shall have a shield and supply of gloves. All personal protective equipment will be cleaned, laundered, or disposed of by the employer at no cost to employees. If an ERT member were to have another person's blood or OPIM splash or soak their clothing, they would make arrangements to remove the contaminated clothing as soon as possible. This clothing would be laundered at the agency's expense. The clothing would be identified as contaminated and any employee, of any employer, exposed to it would be notified and protected from exposure. Contaminated clothing will be bagged in common waste bags with a biohazard sign attached. All repairs and replacements of an ERT member's contaminated personal clothing will be made by the agency at no cost to the employee.

All personal protective equipment will be removed prior to leaving the work area. Gloves used by ERT members are disposable. CPR resuscitation shields are either fully disposable or have a disposable valve. Resuscitation equipment not disposed of will be decontaminated using an appropriate EPA List B registered disinfectant (tuberculocide). See Appendix A for disinfecting and cleaning procedure.

Disposable gloves or any other first-aid materials contaminated with blood or OPIM shall

be placed in normal solid waste trash containers. This material is not considered a "regulated waste" as defined in the Michigan Part 554, Bloodborne Infectious Diseases Standard, Rule 2(w).

First-aid kits and CPR masks will be located at the following locations which are well labeled:

General Office Bldg.- Lansing

➢ Administration & MWHTSD	Office Supply Cabinet
➢ CET Division	Drawers marked First-Aid Supplies
➢ Standards Section	Copy Center Shelves
➢ Construction Safety & Health Division	Drawer marked First-Aid Supplies
➢ General Industry Safety & Health Division	Cabinet marked First-Aid Supplies

Field Offices:

➢ Grand Rapids	Hall Shelf Near Men's Restroom
➢ Cadillac Place	Equipment Room
➢ Saginaw	Library/Conference Room
➢ Lab	Secretary desk, top lateral files

AED's (Automatic Emergency Defibrillator's) are located in the following manner. GOB: near the main aisle, in between the Asbestos Section & Conference Room "H" in the black file cabinet marked AED. Lab: centrally located in the general office area. Grand Rapids Office: on shelf in bookcase in library near secretary. Cadillac Place: equipment room. Saginaw Office: outside conference room.

HOUSEKEEPING AND WASTE DISPOSAL

Janitorial personnel, not employed by MIOSHA or the Michigan Department of Energy, Labor and Economic Growth, staff buildings occupied by MIOSHA personnel. In such circumstances, any extensive clean up of blood or OPIM would be performed by the janitorial service, **not** by ERT members or other MIOSHA personnel.

Medically related incidents which are of a minor nature (i.e., a bloody nose or a paper cut, etc.), meaning no outside emergency medical assistance is required, requires the use of gloves. Disposal of contaminated gloves, with any accompanying band-aid, gauze, toweling, etc. shall be in accordance with the Personal Protective Equipment/Standard Operating Procedure. Potentially contaminated surfaces will be disinfected using facility supplied EPA List B registered disinfectant (tuberculocide).

Major medical incidents, where outside medical assistance is required, will result in all used personal protective equipment, band-aids, gauze, toweling, etc. being placed into designated red bags or containers, as provided by the emergency medical service provider. The emergency medical service provider will then take designated red bags or containers from the building.

HEPATITIS B VACCINE

All ERT members who have been identified as having exposure to blood or other potentially infectious materials will be offered the hepatitis B vaccine, at no cost. The vaccine will be offered within ten working days of their initial assignment to work involving the potential for occupational exposure to blood or other potentially infectious materials unless the employee has previously had the vaccine.

Employees who desire HBV antibody testing before deciding whether or not to receive the HBV vaccination will receive the test at no cost to the employee.

Employees who decline the hepatitis B vaccine will sign a declination statement. These statements will be kept as an employee medical record with the agency's administrative personnel records.

Employees who initially decline the vaccine but who later wish to have it may then have the vaccine provided at no cost. The agency's ERT coordinator(s) are responsible for assuring that the vaccine is offered, administered, or that the waivers are signed. The Ingham County Health Department and Sparrow Occupational Health Service will administer the vaccine and titre.

POST-EXPOSURE EVALUATION AND FOLLOW-UP

When an ERT member renders first-aid or CPR, and experiences an exposure incident, which is an incident where the eye(s), mouth, other mucous membrane, non-intact skin, or punctured into the skin, comes in contact with blood or OPIM, the following must be done:

a. Report the incident to an ERT coordinator(s).
b. Fill out an Incident report. See Appendix "C"
c. Proceed to the identified healthcare facility for evaluation and treatment in accordance with the Michigan Part 554, Bloodborne Infectious Diseases Standard.

Saginaw staff would proceed to:

Covenant Occupational Health Services
600 Irving Street
Saginaw, MI 48607
(989) 583-6130

Grand Rapids staff would proceed to:

Spectrum Health
Occupational Health Services
973 Ottawa, NW
Grand Rapids, MI 49503
(616) 391-7752

Lansing staff would proceed to:

Sparrow Occupational Health Services
1322 E. Michigan Ave Suite 101
Lansing, MI 48915
(517) 364-3900

The post-exposure follow-up will include the following:

- Documentation of the route of exposure and the circumstances related to the incident.

- If possible, the identification of the source individual and the infectivity status of the source individual. The blood of the source individual will be tested (after consent is obtained) for HIV/HBV infectivity.

- Results of testing of the source individual will be made available to the exposed employee. The exposed employee will be informed about the applicable laws and regulations concerning disclosure of the identity and infectivity of the source individual.

- The employee will be offered the option of having their blood collected for testing of their HIV/HBV serological status. The blood sample will be preserved for at least 90 days to allow the employee to decide if the blood should be tested for HIV serological status. However, if the employee decides prior to that time that testing will be conducted, then the appropriate action can be taken and the blood sample discarded.

- The employee will be offered post-exposure prophylaxis in accordance with the current recommendations of the U.S. Public Health Service.

- The employee will be given appropriate counseling concerning precautions to take during the period after the exposure incident. The employee will also be given information on what potential illnesses to be alert for and to report any related experiences to appropriate personnel.

INTERACTION WITH HEALTH CARE PROFESSIONAL

Whenever the employee is sent to a health care professional following an exposure incident, a written opinion shall be obtained from the health care professional who evaluates ERT members of MIOSHA within 15 working days of the completion of the evaluation. A copy of the required written opinion will be supplied to the employee.

Health care professionals shall be instructed to limit their opinions to:

- Whether the Hepatitis B vaccine is indicated and if the employee has received the vaccine, or for evaluation following an incident.

- That the employee has been informed of the results of any and all evaluations, including HIV, and;

- That the employee has been told about any medical conditions resulting from exposure to blood or other potentially infectious materials. (Note that the written opinion to the employer is not to reference any personal medical information.)

TRAINING

1. Initial training for all ERT members will be conducted prior to assignment of tasks where occupational exposure may occur and annually thereafter.

2. Training for employees shall include an explanation of the following:

    - The MIOSHA Part 554, Bloodborne Infectious Disease Standard.
    - The epidemiology and symptoms of bloodborne infectious diseases.
    - Modes of transmission of bloodborne infectious diseases.
    - This Exposure Control Plan, i.e., points of the plan, lines of responsibility, how the plan will be implemented, etc.
    - Procedures which might cause exposure to blood or other potentially infectious materials at this facility.
    - Control methods which will be used at the facility to control exposure to blood or other potentially infectious materials.
    - Personal protective equipment available at this facility and who should be contacted concerning the equipment.
    - Post-exposure evaluation and follow-up.
    - Signs and labels used at the facility.
    - Hepatitis B vaccine program at the facility.
    - Additional items described in Rule 16, of MIOSHA's Part 554, Bloodborne Infectious Diseases Standard.

3. The ERT coordinator(s) prompt members that a quarterly First-Aid Kit inspection will be performed and documented when they are notified of training. Inspection records are to be maintained with the location's Exposure Control Plan. Training for ERT members shall involve lectures, videos, and hands-on sessions.

<u>RECORDKEEPING</u>

The agency shall establish and maintain an incident record for each employee with occupational exposure and keep it for the duration of employment plus 30 years. Records shall be kept confidential. The incident report shall include at the very least all of the following (see Appendix "C"):

Name
Hepatitis B vaccine status
Copies of any past exposure/evaluation or follow-up

Training Records:

Date(s)
Summary of Contents
Names and qualifications of trainers
Names and job titles of all trainees
Maintain record for three (30) years

The emergency response team member shall keep hepatitis vaccination records until all three shots in the series are completed. At that time, a copy of the vaccination record will

be placed in the MIOSHA files.

Agency Administration shall keep records for the MIOSHA Emergency Response Team.

ANNUAL REVIEW AND CONSIDERATION- CHANGES IN TECHNOLOGY THAT ELIMINATES OR REDUCES EXPOSURE TO BLOODBORNE PATHOGENS

The following protective work clothing and/or equipment is being considered and/or implemented:

The following work practice controls are being used to reduce exposure:

UNIVERSAL CONTROLS/PRECAUTIONS

.