LAKE MICHIGAN® COLLEGE

CHEMICAL HYGIENE PLAN

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LAKE MICHIGAN COLLEGE'S STATEMENT OF COMMITMENT TO PROVIDE A SAFE WORKING AND LEARNING ENVIRONMENT.

Lake Michigan College (LMC) is committed to providing a safe work environment for the health and well-being of its employees and students. We have developed the following Chemical Hygiene Plan (CHP) to support that commitment and to promote a culture of safety within the college.

Contained herein are the procedures, prepared in accordance with the State of Michigan Occupational Safety and Health Administration (MIOSHA) requirements, for the protection of LMC students, faculty, and staff. Faculty, staff, and student employees working in laboratory areas should become familiar with the information covered in this document.

Although students are not included in the regulatory requirements of the MIOSHA Lab Safety Standard, LMC expects students who carry out laboratory research to be familiar with the basic information contained in the CHP. All students must comply with the established safety rules when participating in an LMC science laboratory.

1.0 SCOPE

1.1 Lake Michigan College Statement of Responsibility

Lake Michigan College, as a responsible employer, is committed to taking every reasonable precaution to provide a work environment free from recognizable hazards for its employees and students. LMC academic programs include laboratory work, therefore this CHP has been prepared in compliance with the MIOSHA Hazardous Work in Laboratories Standard (Part 431), to ensure necessary work practices and procedures are implemented to protect employees and students working in laboratories, owned and operated by LMC, from hazards typical of a laboratory environment.

Therefore, LMC employees assume the responsibility to be well informed about hazardous materials and their associated risks in a laboratory setting.

> **Hazardous Material:** Any chemical, biological, or radiological substance for which there is significant evidence that acute or chronic health effects may occur in exposed personnel. The term "health hazard" includes chemicals that are carcinogens, toxins, irritants, corrosives, sensitizers, or other agents that can damage the lungs, skin, eyes, or mucous membranes, select biological agents which can cause disease or death, or a quantity of radioactive material. Lake Michigan College also considers the use of equipment or instrumentation, or other physical agents that have been identified as hazardous to be included in the definition of hazardous materials above, as it applies to laboratory operations.

1.2 Scope and Application

This document serves as a guide for LMC compliance with the MIOSHA Hazardous Work in Laboratories Standard and the Chemical Hygiene Plan requirements. All programs and facilities at LMC engaged in the laboratory use of hazardous materials are required to comply with this document.

The primary objective of this CHP is to provide general guidelines (1. Rules and Policies) for handling hazardous materials in laboratories. The plan establishes basic safety principles for laboratory procedures, equipment, and work practices capable of protecting employees from laboratory hazards. Persons associated with LMC working with hazardous materials outside of a laboratory must comply with MIOSHA standards. The CHP is a regular, continuing effort, not a standby or short-term activity. This document is intended to highlight those safety measures necessary for achieving a safe and healthy work environment. Additionally, as programs expand and faculty and staff revise academic programs, this document will be updated accordingly.

This Plan does not apply to:

1. Work with chemicals or biological materials that do not meet the criteria to be considered hazardous by the MIOSHA Hazardous Work in Laboratories Standard.

2. Work with chemicals or biological materials that create no risk of exposure to employees.

This document will hereafter be known as the LMC Chemical Hygiene Plan (CHP).

This plan has been developed to comply with Michigan Department of Labor and Economic Growth Occupational Health Hazardous Work in Laboratories Standard. A link to this Standard can be found in Appendix A. The intention of this plan is to serve as an employee reference for safe work practices in the laboratory.

2.0 RESPONSIBILITY

Chemical Hygiene Officer (CHO) is the chemical hygiene authority. The CHO shall work closely with the Environmental Health and Safety Committee, the LMC Public Safety Director, and academic units for overall compliance with the CHP. The CHO can delegate responsibility to others, as necessary, to implement and carry out the provisions of the CHP.

LMC Public Safety Director is responsible for the development and implementation of procedures to establish and maintain an environmentally healthy and safe workplace. The Public Safety Director and Chemical Hygiene Officer serve as resources for compliance with the CHP.

College Employees whose job responsibilities are laboratory-based are responsible to be familiar with the safe practices and requirements of the CHP and building-specific health and safety procedures for their own safety. All individuals performing work with hazardous substances must accept a shared responsibility for working in a safe manner once they have been informed about the extent of risk and of safe procedures for their activities. They also have the responsibility to inform their unit heads of accidents and work practices or working conditions that they believe to be hazardous to their health or to the health of others. Standard reporting procedures and forms are available from the lab supervisor.

Academic Deans and their designees are responsible for the overall safety and well-being of faculty, staff, and students in that they can make available the resources necessary to carry out the provisions of the CHP.

Faculty will provide students and staff with training at the beginning of each course or research project in which hazardous materials are used. The training shall be documented as described later in this document. Specific safety training instructions will be provided at the beginning of each class period on an as needed basis.

All roles assume responsibility of enforcing the policies and rules of the CHP. Failure to comply may result in disciplinary action.

3.0 STANDARD OPERATING PROCEDURES

This CHP contains standard operating procedures (SOPs) that apply to laboratory work involving the use of hazardous chemicals, hazardous biological materials, and/or operations with a high degree of risk. SOPs have been prepared to bring about uniformity in lab activities, thereby adding a higher level of safety.

3.1 General Safety Principles

The following guidelines have been established to assist faculty and staff who work in laboratories in managing potential hazards and to maintain a basic level of safety. Detailed below are guidelines that can be used in establishing minimum requirements for those who may use and/or work in labs.

1. Examine the known hazards associated with the materials being used. Never assume all hazards have been identified. Carefully read the label before using an unfamiliar chemical. When appropriate, review the Safety Data Sheet (SDS), formerly the Material Safety Data Sheet (MSDS) (see Section 5.5 for SDS info) for special handling information. Information relating to SDS/MSDS's can be found in Appendices C and D. Determine the potential hazards and use appropriate safety precautions before beginning any new operation.

2. Be familiar with the location of emergency equipment - fire alarms, fire extinguishers, emergency eyewash, and shower stations. Know the appropriate emergency response procedures and be prepared to perform them, as necessary.

3. Avoid distracting or startling other workers when they are handling hazardous materials.

4. Use equipment and hazardous materials only for their intended purposes.

5. Always be alert to unsafe conditions and actions. Call attention to them so that corrective action can be implemented as quickly as possible.

6. Wear eye and face protection, as well as any other PPE requirements, when appropriate.

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

8. Avoid tasting or directly smelling chemicals.

3.2 Health and Hygiene

The following practices have been established to protect laboratory employees from health risks associated with the use of hazardous chemicals:

1. Avoid direct contact with any hazardous material. Know the types of protective equipment required while using any chemical. If in doubt, review the appropriate section of the SDS/MSDS.

2. Confine long hair and loose clothing. Footwear must fully cover feet. Clothing should cover from ankle (at least below the knee) to shoulders and out to wrists (at least, the elbow).

3. Do not mouth-pipette.

4. Use appropriate safety equipment whenever there is a potential for exposure to hazardous gases, vapors, or aerosols. Check to ensure that local exhaust ventilation (fume hood and/or snorkel) equipment is working properly before use. In the event that general (room) or local (fume hood) exhaust ventilation is not functioning properly, immediately stop work with hazardous materials and notify facilities management to report the malfunction. Place a sign on the safety equipment to notify others that work with hazardous materials is suspended until the equipment is working properly.

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

6. Chemical Splash Safety Goggles (indirectly vented) shall be worn as eye protection whenever use is directed by the SDS/MSDS. Students must follow instructor directions relating to goggle use.

7. Clean and store personal protective equipment as appropriate.

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

3.3 Food and Drink in The Laboratory

1. Eating, drinking, smoking, or applying of cosmetics in any laboratory area where hazardous chemicals or biologicals are used or stored is not permitted at any time. This procedure applies to natural science and non-natural science classes, meetings, club functions, and any other activities taking place in LMC labs.

2. Refrigerators and microwave ovens used for chemical or biological storage or other laboratory use shall not be used for food storage or preparation.

3. Food and beverages intended for human consumption may not be stored in the laboratory.

3.4 Housekeeping

Proper housekeeping practices are paramount to safety in the lab. The following guidelines can be used to maintain an orderly laboratory.

1. Keep work areas (including floors) clean and uncluttered. Thoroughly clean work areas after the work is finished and/or at the end of each lab or workday.

2. Dispose of waste per the LMC disposal policies described in Section 4.0.

- A separate receptacle must be designated for non-contaminated glass. Contaminated glass is considered hazardous waste and disposed of accordingly.

3. Address spills immediately per the guidelines established in Section 7.0 of this document. Ensure a chemical spill kit is available. Faculty, staff, and students are

to be trained on the proper procedures of cleaning a spill and a designated employee shall assure that the spill kits are properly stocked.

4. Do not block exits, emergency equipment or controls. These must always remain unobstructed. Do not use hallways or stairwells for storage.

5. Assure hazardous chemicals are properly segregated into compatible categories (Section 4.0).

6. Custodians are not to clean up chemicals or biohazards. Custodial responsibilities are limited to cleaning the floors (except when chemicals and biologicals are present), countertops and tabletops, boards and emptying the trash.

3.5 Prior Approval

At times, it may be necessary to leave a laboratory operation unattended. Follow these basic guidelines in the design of an experiment or project to be left unattended: Always check with your laboratory supervisor to determine if a laboratory operation can be left safely unattended. If the operation is to be left unattended for extended periods and involves hazardous materials or potentially hazardous conditions, develop a protocol to be reviewed by the laboratory supervisor and CHO. The protocol should serve as failsafe operations, including responses to potential interruptions in electric, water, inert gas and other services and provide containment for hazardous materials.

1. A warning notice must be posted near the experiment if hazardous conditions are present. This notice must contain information concerning the hazard, such as indicators of problems and who to contact if such evidence is present.

2. Avoid working alone whenever possible. Do not work alone in a laboratory if the procedures being conducted are hazardous or involve the use of hazardous materials. If one must work alone, let another LMC employee or LMC security know the expected times you will be in the lab.

3. Do not ship hazardous chemicals using commercial vendors without prior approval from the CHO. The Department of Transportation has extremely specific regulations governing the shipping of hazardous materials. Failure to comply with these regulations could result in severe penalties. Consult the Lab Manager with any questions regarding shipping of hazardous materials.

4. Do not transport any chemical or hazardous material outside of the College without prior approval from the Lab Manager. The employee is responsible for ensuring that the Department of Transportation regulations on shipping chemicals are not violated by transporting chemicals in a private car or on a

commercial carrier. The CHO will assist with any questions regarding these regulations.

5. Contact the CHO for the proper disposal requirements and methods for all chemical wastes. Keep a detailed inventory of the contents and quantities of waste placed into the waste container.

6. When work with a toxic, corrosive, or reactive gas is planned, the CHO should be contacted for information concerning specific handling requirements. These gases will need to be used and stored with local exhaust ventilation such as a lab hood or a gas cabinet designed for that purpose.

    - In general, outside contractors/suppliers have been hired to exchange empty cylinders with full ones. In general, faculty and staff should limit moving cylinders around the building. Please refer to the building–specific plan for more information regarding the gas cylinder exchange policy.

7. The Lab Manager must give prior approval before any new or non-routine task is started that involves the use of hazardous materials. The following items require prior approval:
    - The same procedure but with new or different materials.
    - Any significant change in the procedure, particularly changes in temperature or pressure.
    - The use of new equipment or equipment that has been in storage.
    - A significantly new procedure.

3.6 Instructor Training

All new Natural Science instructors, both full time and adjunct, are required to view the Lake Michigan College Natural Science Instructor Safety Course (a PowerPoint presentation) at the time of their hire. The Natural Sciences Lab Manager is responsible for the content and review/updating of the Safety Course.

3.7 Lab Safety Agreements

Each student in all Natural Science course sections is required to participate in an instructor-led presentation concerning the Lab Safety Agreement (LSA). The LSA is specific to each course and should be presented by the instructor at the beginning of the semester, preferably, the first or second class session. The LSA is a guideline for student safety, conduct and emergency response in a laboratory setting. The Natural Sciences Lab Manager is responsible for LSA content and review.

4.0 CHEMICAL DISTRIBUTION/STORAGE/INVENTORY/DISPOSAL

The decision to use a hazardous material should follow a commitment to handle and use the material properly from initial receipt to disposal. Information on proper handling, storage, and disposal of hazardous materials and access to related SDS/MSDS is available to all laboratory employees by contacting the CHO.

4.1 Ordering Chemicals

Stockroom personnel, Lab Manager or Lab Coordinator, are to order chemicals. Purchase the minimum amount necessary to maintain regular operations.

When ordering chemicals:

1. Check the chemical inventory to verify that the chemical is not already available in the department.

2. Obtain information concerning proper handling, storage, and disposal of the chemical.

3. Determine the minimum amount of chemical needed to complete the work. Do not order extra amount of chemicals that will not be used in a timely manner. Disposal costs far outweigh the slight cost savings accrued when ordering large quantities. Chemicals must arrive with the proper hazard communications labeling and SDS/MSDS. Do not accept a chemical container without the proper hazard communications labeling.

4.2 Chemical Stockrooms and Storerooms

Stockrooms are defined as areas where chemicals are mixed, repackaged and/or distributed for laboratory use. Storerooms are defined as areas where chemicals are stored with no manipulation of chemicals. A single area may serve as combined stockroom/storeroom.

1. Chemical containers are to be marked, upon arrival, with “Date Received” and when first used with “Date Opened”, in MM/DD/YYYY format.

2. Store hazardous materials, when not in immediate use, in an environmentally controlled, supervised stockroom, storeroom, or storage cabinet.

3. Record the removal of any chemical or apparatus for inventory purposes.

4. Do not transport chemicals from the stockroom unless they are in an appropriate container.

5. Clearly mark all materials brought to the stockroom for waste disposal with the chemical content, the employee responsible for their disposition, and the location where the waste materials were accumulated.

4.3 Chemical Storage

Follow these general procedures for storage of chemicals:

1. Conduct annual inspections to check containers for deterioration and sample integrity.
2. Store the smallest amount of hazardous material as practical in the laboratory.
3. Do not use fume hoods as storage areas for chemicals.
4. Store chemicals in cabinets or on shelves, not on the floor.
5. Store chemicals according to hazard class, not alphabetically.
6. Do not store incompatible materials together.
7. Secure bottle caps to prevent accidental spills and minimize odors.
8. Implement spill trays in liquid storage areas.
9. Store large quantities and heavy chemicals on low shelves.
10. Lightweight or small quantities may be stored above eye level.
11. Do not store corrosive materials of any quantity above eye level.
12. Wear appropriate PPE, including eye protection, when handling chemicals stored above eye level.
13. Keep a ladder or step stool available for reaching overhead storage.
14. Store chemicals away from heat and direct sunlight.
15. Conduct periodic, scheduled inventories. Chemicals not required for current work are to be returned to the stockroom for storage or proper disposal.
16. Avoid using containers commonly associated with food products.

4.4 Flammable Liquid Storage

Store flammable liquids, when not in use, in flammable storage cabinets designed specifically for and labeled as “Flammable” or the C-309 Flammables Room. Do not store other materials with flammables.

Store plastic squeeze bottles containing flammable materials (such as those used as solvents for rinsing) in a flammable storage container.

4.5 Corrosive Liquid Storage

1. Store mineral acids, such as sulfuric and hydrochloric acids, in acid storage cabinets.

2. Store bases and solutions of bases separately from acids.

3. Store oxidizing acids, such as nitric and perchloric acids, with oxidizing materials and away from organics.

4. Store organic acids, such as acetic and formic acids, with flammable materials.

4.6 Oxidizer Storage

1. Store oxidizers, such as hydrogen peroxide and chlorine bleach, away from all organic materials and reducing agents.

2. Do not store near combustible materials.

4.7 Compressed Gas Storage

1. Chain or secure all gas cylinders to a permanent fixture and store with the caps on when not in use.

2. Store oxygen cylinders away from fuels and other combustible materials.

3. Mark empty cylinders as “Empty” and store away from other cylinders.

4. Toxic gases
    - Toxic gas cylinders must be dated when they arrive. Order the smallest quantity needed for the work.
    - Toxic gases must be stored and used in a ventilated gas cabinet, exhausted enclosure, or a ventilated separate gas storage room.
    - Gases that are not being used should be turned in to the CHO. Toxic gases that are kept for more than one year can degrade, or the cylinder

and connections can degrade in such a way as to become very unstable and dangerous. In general, all toxic gas cylinders should be turned in to the CHO within one year from the delivery date.

- Emergency procedures should be made clear to all involved, including personnel from adjacent labs.
- Fume hoods and other ventilation need to be tested before use and checked frequently during the project involving toxic gas.

4.8 Toxic Chemicals and High-Risk Chemicals

1. Store toxic materials separately from other chemicals.
2. Store in a vented cabinet.
3. Store materials that are highly acute toxins and other high-risk chemicals with the parent container inside an unbreakable secondary container.
4. Post specific warning signs on the storage area.
5. Maintain records of use and disposal.

4.9 Reactive Chemicals

1. Store reactive chemicals away from other chemicals.
2. Store water reactive chemicals in cabinets protected from the fire sprinkler system.
3. Store specified reactive materials under either inert atmosphere and/or refrigeration.
4. Inventory materials that may form organic peroxides and dispose of them at the time of expiration.
5. Store explosive materials as specified by the manufacturer. Only knowledgeable and trained individuals may handle these materials.

4.10 Hazardous Chemical Inventory

Maintain inventory of all hazardous chemicals in a central department location. Update the inventory at least annually and forward a copy, upon request, to the Public Safety Director for regulatory reporting. The Lab Manager will oversee the inventory procedures.

4.11 Hazardous Waste Disposal

The goal of a waste disposal program is to reduce potential harm to people and the environment that could result from the improper disposal of a hazardous chemical. Consider first the minimization of the amount of waste generated. If possible, use non-hazardous alternatives. Recycle or reclaim materials when possible. Know the disposal requirements before ordering a new material. Hazardous waste is defined in the Federal Resource Conservation and Recovery Act (RCRA). Waste is considered toxic and/or hazardous according to RCRA if it will "cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed." RCRA regulations (40 CFR 261 and 262) specify that a waste is hazardous if it is a listed waste or has the characteristics of a hazardous waste. A hazardous waste meets any of the following conditions:

1. Has been named as a hazardous waste and listed as such in the regulations.
2. Exhibits any of the characteristics of a hazardous waste (ignitable, corrosive, reactive, toxic).
3. Is a mixture containing a listed hazardous waste and a non-hazardous waste.
4. Is a waste derived from the treatment, storage, or disposal of a listed hazardous waste.

Mixture Rule

A listed hazardous waste plus a non-hazardous waste is always a hazardous waste. A characteristic hazardous waste plus a non-hazardous waste may or may not be a hazardous waste depending on whether the resulting waste demonstrates characteristics of a hazardous waste. *See Lab Manager if there are any questions on whether a waste is hazardous or not.*

The following procedures apply to hazardous waste containers in laboratories:

1. Waste disposal
    - Place a "Hazardous Waste" label on hazardous waste containers before any waste is put into it. Include the words "hazardous waste" on the label along with a description of the waste.
    - Keep containers closed when not in use.
    - Use only containers that are in good condition.
    - Keep containers under the generator's control.
    - Inspect containers on a regular basis.
    - Keep an inventory of the contents. Record the name and amount of each chemical added to the waste container along with the date it was added.
    - When adding new waste to a container, check to see that the new waste is compatible with the original contents.

- Date waste containers when waste is first placed in the container.
- When the container is full, complete the hazardous waste label with percentages of each chemical and the date the container became full. The % column must equal 100%.
- A container is full when the liquid level reaches approximately ¾ of the container volume. This will prevent the build-up of excessive vapors while ensuring adequate room for expansion.
- Notify the Lab Manager for waste pick-ups.

2. Drain disposal of chemicals

    - Salts, sugars, and starches that do not contain any hazardous material may be put down the drain if they present no possibility of coagulation within the drain.
    - "Neutral" buffer solutions (pH between 6 and 8) may be put down the drain.
    - Drain disposal of all other chemicals is prohibited.

3. Laboratory glass waste

    To protect LMC staff, glass may not be discarded in the regular trash. Lab glass should be disposed of in a designated "broken glass" receptacle. Glass waste that is not broken and does not require hazardous waste disposal is also to be discarded in the "broken glass" container. The laboratory staff will properly dispose of broken glass boxes. The rules for the glass waste are as follows:

    - Glass only.
    - No liquids.
    - No highly toxic residues.
    - No needles or razor blades. These are to go into a "SHARPS" container.

4. Sharps waste

    "Sharps" items include needles, syringes, lancets, and razor blades. These items should be collected in a leak proof, puncture-resistant container labeled for sharps collection.

5.0 UNDERSTANDING AND RECOGNIZING CHEMICAL HAZARDS

To ensure that employees of Lake Michigan College (LMC) are not overexposed to chemicals, each employee must be knowledgeable of the chemical hazards in his/her work environment. Each employee must be able to identify chemical hazards and understand what measures can be taken to eliminate chemical hazards. This section addresses how to understand and recognize chemical hazards.

5.1 Employee Information and Training

The primary way to ensure that employees understand and recognize chemical hazards is through training. LMC will provide training to its employees (students, faculty, staff) who work in areas where hazardous materials are used or stored and to those who work in areas where hazardous materials are not used or stored yet have the potential for incidental exposure because they are located in the same building. New employees must receive training on the requirements of the CHP prior to working with chemicals in the laboratory. Refresher training will be provided when procedures are updated in the CHP. Employee training records will be on file at the following locations:

A. Office of the Public Safety Director.

B. Office of the Chemical Hygiene Officer.

Training will include the following:

1. The content, location, and availability of the chemical hygiene plan.

2. How to read SDS/MSDS, chemical labels, and pictograms in compliance with the GHS (see next page).

3. Safe handling of chemicals.

4. Chemical storage at LMC.

5. The LMC Lab Safety Agreement.

6. Use of personal protective equipment (PPE) and safety hardware (fire extinguishers, eyewashes, showers, etc.)

7. First aid and emergency procedures (spills, exposure, fire, accidents etc.)

8. The Standard Operating Procedures which employees can use to protect themselves from hazards, including General Safety Principles, Health and Hygiene, Food and Drink in the Lab, Housekeeping and Prior Approval.

If there are any questions about CHP training (to whom it applies, training dates and times, etc.), contact the CHO or the Public Safety Director.

5.2 Identification of Hazardous Chemicals

Before starting any procedure that requires the use of a chemical, you must identify the hazards associated with the chemical. Reading and understanding the warning or hazard labels on the chemical containers and the Safety Data Sheet (SDS, formerly

MSDS) for each of the chemicals used can help achieve this. Other references are available through the CHO. See Section 8.0 for more detail on the different classifications of hazardous chemicals.

5.3 Signs

At a minimum, the following signs should be posted for each laboratory:

- A listing of telephone numbers for LMC Lab Manager, facilities management, and supervisory personnel on the outside of the lab door.

- Location signs for safety equipment, such as safety showers, eye wash stations, fire extinguishers, emergency cut-off switches, and first aid equipment. Students will be apprised of safety equipment locations during Lab Safety Agreement review.

- Signs designating the location of SDS/MSDS information.

- Signs designating the areas where food and beverages are NOT permitted.

- Warning signs where dangerous equipment is in use or where potentially dangerous operations are taking place.

5.4 Chemical Labeling

At a minimum, each new chemical container must be labeled with the following:

1. Name of chemical.
2. Hazard warnings.
3. Name and address of supplier.
4. Chemical concentration.

At a minimum, each transfer chemical container must be labeled with the following:

1. Name of chemical (no abbreviations).
2. Chemical formula.
3. Chemical concentration.
4. Initials of the staff member who prepared the transfer chemical.
5. Date of preparation.

Solutions mixed in-house should be marked with the following:

1. Name of chemical (no abbreviations).
2. Chemical formula.
3. Chemical concentration.
4. Initials of the staff member who mixed the chemical.
5. Date the chemical was mixed.

Containers of non-hazardous materials (e.g. Distilled Water) must also be properly labeled. Dispose of unlabeled containers and its contents as unknown hazardous waste.

5.5 Safety Data Sheets (SDS), formerly Material Safety Data Sheets (MSDS)

LMC shall maintain copies of Safety Data Sheets (SDS, formerly MSDS) for each hazardous chemical used in the laboratories. SDS must be readily accessible during each work shift to employees in their work area.

5.6 Chemical Inventory

LMC shall maintain a comprehensive chemical inventory. The inventory will be updated at least annually. Store all chemicals safely and properly. Store chemicals according to chemical classification and hazard, and keep incompatible materials separated. Do not store chemicals alphabetically.

5.7 Inspections

Laboratories shall be inspected at least annually. A sample laboratory inspection checklist can be found in Appendix F. Include personal protective equipment (PPE), safety equipment, electrical cords, laboratory equipment, and general laboratory conditions during the inspection. If you discover any defective equipment during the safety inspection, tag it, take it out of service, and have it repaired. If the equipment is not going to be repaired, then it is recommended that the item is either disposed of or removed to a storage location. Maintain a file of inspection checklists and logs.

The CHO will be responsible for inspecting/flushing safety showers and plumbed eyewash stations. Any safety shower or eyewash not passing the inspection will be immediately tagged and taken out of service until it is repaired.

Facilities Management will be responsible for inspecting the performance of chemical fume hoods annually. If any hood does not pass the inspection, it will be immediately tagged and taken out of service until it is repaired.

Facilities Management will be responsible for inspecting fire extinguishers monthly.

6.0 REDUCING EXPOSURE TO CHEMICALS

Chemical safety is achieved through continual awareness of chemical hazards and by minimizing chemical exposures through engineering controls (e.g., ventilation), personal protective equipment, and proper lab practices.

6.1 Permissible Exposure Limits

The Laboratory Standard requires that employers, for laboratory uses of substances regulated by OSHA/MIOSHA, assure employees' exposures do not exceed the Permissible Exposure Limits (PELs). The PELs represent Time Weighted Averages (TWA's) in parts per million (ppm) or milligrams of substance per cubic meter of air (mg/m3). The TWA represents the ratio between exposure and work shift. PELs can be found in the Occupational Health Standard Part 301 of Michigan's Department Of Labor and Economic Growth. An additional reference, the American Conference of Governmental Industrial Hygienists (ACGIH), has established Threshold Limit Values (TLV's), which are TWA values similar to PEL's. Refer to SDS/MSDS and/or MIOSHA's web site for exposure limits and related information.

6.2 Ventilation

General room ventilation is not usually sufficient to prevent the accumulation of chemical vapors; therefore, when working with toxic chemicals, use a chemical fume hood or chemical fume snorkel.

6.3 Ventilation Testing

The chemical fume hoods will be tested annually by Facilities Management. If any hood is not working properly, then it will be tagged out of service until the repairs are made. While the hood is out of service, it cannot be used for chemical applications.

6.4 Use of A Chemical Fume Hood

Chemical fume hoods are protective equipment and must be used correctly to offer protection from chemical exposure. The following is a list of procedures that must be followed to ensure that the ventilation is constant and properly functioning.

1. Keep all laboratory doors to the hallway closed. This will aid in keeping the hallways at a positive pressure and the laboratories at a negative pressure so chemical odors will not migrate out of the lab.

2. Keep windows closed in the laboratory. Drafts and eddy currents can cause turbulence at the face of the hood that may allow chemical vapors to escape from the hood.

3. Hood sashes are to be used in a lowered position with a maximum opening of 18 inches, except when actively positioning equipment, to ensure proper safety. Fume hoods are designed to eliminate chemical inhalation exposure. When the sash is wide open, the hood cannot not trap adequate amounts of the chemical vapor. When the hood is not in use (i.e., not venting chemical vapors), close the sash completely.

4. For hoods that contain manual flow controls, place the face velocity setting at 100 ft/min before using the hood. Allow 3-5 minutes for the hood to stabilize and reach the new face velocity setting prior to beginning work. A safe working range for a hood is 80-120 ft/min. When the hood is not being used, the setting should be turned to minimum for standby mode. To obtain a quick flush of the hood following a chemical spill in the hood, lower the sash to about an 8-inch open height, set the controller to 200 ft/min for 3-5 minutes, then return the controller to 100 ft/min for regular use. Hoods that do not contain manual flow controls will be adjusted to maintain a face velocity of around 100 ft/min when turned on with the sash raised to 18 inches.

5. Keep storage of chemicals and equipment in the hood to a minimum (i.e., only materials in use). If the hoods become cluttered, then airflow is blocked. A spacious work area inside the hood will allow the user more room to work safely and efficiently.

6. Place items at least six inches away from the front edge for better capture of vapors.

6.5 Personal Protective Equipment (PPE)

Workplace Assessments

Perform a workplace assessment in each laboratory to determine if hazards requiring the use of PPE are present. If potential hazards are present in the laboratory, do the following:

- Identify each hazard and the source.
- Determine which body parts may be affected.
- Select appropriate PPE against the hazard.
- Train each employee on the hazards present and when PPE should be worn.
- Train employees on the proper use, maintenance and limitations of each PPE device used.
- Maintain training records within the department.

Do not rely upon PPE alone to completely protect against hazards. Rather, use it in conjunction with effective engineering controls and workplace practices to minimize hazards in the workplace.

6.6 Eye Protection

All safety eyewear must meet the ANSI Z87.1 standard for minimum allowable eye protection. All eye protection supplied by LMC must meet this standard.

Safety glasses do not give adequate protection from chemical splashes. All lab participants at LMC are provided with safety goggles.

Contact lenses do not provide eye protection. Wearing contact lenses is discouraged when working with materials or procedures that give off gases, vapors, welding fumes, smoke, or dust. If you choose to wear contacts, be aware of the hazards of wearing contacts in a lab.

Eye Protection is required…

- When working with or in the vicinity of solvents or corrosive chemicals, or with any chemical that could produce an eye injury.
- When working near equipment or apparatus under high pressure or vacuum, or when around equipment that could produce projectiles.
- When near laboratory benches where chemical reactions are being run or when around a radiation hazard.
- When transporting flammable, corrosive, or toxic chemicals.
- During maintenance activities involving chemicals, hand/power or machine tools, welding, cutting, grinding, or abrasive blasting.
- When working behind hood doors or blast shields.

6.7 Gloves

Gloves provide protection against chemical, radiological and biological agents. Selection of proper gloves for the work task is critical in maintaining protection against hazardous agents. The CHO can assist employees in the selection of proper gloves.

Note the Following for Safe Glove Usage:

- When working with corrosive liquids, solvents, or other potentially hazardous materials, wear proper gloves. One type of glove will not protect against all chemicals; therefore, proper glove selection is critical.
- Remove gloves prior to answering phones, using computers, opening doors, or any other situation that might cause the spread of hazardous materials.
- Remove gloves prior to leaving the laboratory area.
- Wash hands anytime gloves are removed.

- Be careful not to touch other parts of your body or apparel while wearing gloves (e.g., scratching, pushing up glasses, etc.).
- Dispose of gloves as hazardous waste if they meet the characteristics of a hazardous waste (see Section 4.14).

6.8 Respiratory Protection

Respirators are designed to keep the wearer from inhaling toxic chemicals or other contaminants in the air during accidents, emergencies or when engineering controls are not sufficient to maintain exposures below the Permissible Exposure Limit (PEL). **If you plan to use a respirator, see the CHO prior to use.** Respirators have inherent hazards, should be considered the last line of defense, and should not be used during routine laboratory operation. When required, respirators are available to employees at no cost.

Departments shall make every effort to use engineering and workplace controls to minimize exposures. Respirators shall only be used when engineering controls and workplace practices fail to reduce the exposures below the PEL. Departments' responsibilities include:

- Inform the CHO of potential health hazards that may require the use of respirators.
- Ensure employees receive a respirator fit test prior to respirator usage.
- Ensure employees have received proper medical and training clearance before they start using respirators.
- Ensure employees use and store the respirator in compliance with the Respiratory Protection Program.
- Ensure respirators are stored in a closed container, shelf, or cabinet.
- Ensure respirators are kept clean and dust-free and washed when necessary.
- Ensure respirator cartridges are changed on a regular basis according to specifications or use limitations.
- Require training for all employees using respirators. Make sure training is recorded and on file with the CHO.
- Monitor the respirator program for compliance and report deficiencies to the CHO.

6.9 Laboratory Attire

Wear appropriate clothing in the laboratory. Shorts, short skirts, halter tops, high heels, sandals, open-toed shoes, and shoes with uppers constructed of woven material are not recommended. Tie back long hair and loose clothing and remove dangling jewelry prior to working in the laboratory.

6.10 Laboratory Practices

Proper lab practice can greatly reduce exposure to chemicals. If a chemical is highly hazardous, then substituting a less hazardous chemical that will accomplish the same procedure is strongly suggested.
Always observe the following practices:

- Be familiar with the chemicals being used and the associated signs and symptoms of exposures.
- Do not eat or drink in a laboratory area.
- Wash hands prior to leaving the laboratory.
- Label unattended operations with name, contact phone number, and a brief description of the apparatus, reaction, and chemicals.

7.0 CHEMICAL EMERGENCY ACTION

Always be prepared. One of the best ways to avoid emergencies is to think and plan ahead. Know the main and alternate evacuation routes from the area. Prior to working with chemicals in the laboratory, locate the following items:

- Eyewash
- Emergency shower
- First aid kit
- Fire extinguisher
- Spill-control kit
- Emergency shut-off valves
- Telephone
- Emergency phone numbers (names of contact personnel should be listed on the laboratory doors, and it is recommended that phone numbers of contact personnel be posted near phones.

7.1 Spill Procedures

The most common incidents involving hazardous materials usually involve a liquid spill or the accidental release of a gas or vapor. Fires and explosions can also occur. As the quantities used in most procedures at LMC, spills will usually be small. However, vapor released from a small spill can be dangerous either if inhaled or if it is flammable. Any spill of a hazardous material outside of a chemical fume hood is considered dangerous, and steps to remediate must be taken immediately.

Spills are classified as either hazardous or incidental. A hazardous spill is an emergency of unknown nature, a situation which may be immediately dangerous to life and health, is a threat to personnel and/or the public, threatens the surrounding area or facility, and/or involves a toxic gas leak, or a toxic, corrosive, or reactive hazardous material. Members of a hazardous cleanup response team will clean up all hazardous spills.

An incidental spill creates no fire hazard and involves low to moderately toxic materials in small amounts which can be absorbed, neutralized, contained, or otherwise controlled by employees in the immediate release area. In general, incidental spills can be cleaned up by the individual who was using, storing, or transporting the material spilled, if they are properly trained and use approved spill cleanup kits and PPE. If the individual is not properly trained, another trained individual should be called for the cleanup.

a. Hazardous Spills

In the event of a hazardous chemical spill, do the following:

- Eliminate all sources of ignition and evacuate the immediate area.
- Close all doors leading into the spill area.
- If applicable, assist contaminated persons to a safety shower or eyewash station.
- Notify LMC Facilities Management. Call 6-911 from a campus phone or 911 from a cell phone.
- Report the spill immediately to your supervisor and to the Lab Manager. Report whether the spill has entered the air, ground, sanitary or storm sewers, or any surface water.
- All toxic spills that have an LD_{50}<50 mg/kg are considered highly toxic and must be reported immediately to your supervisor and to the CHO. These might include suspect carcinogens or reproductive toxins.

a.1. General LMC Hazmat Spill Procedure

1. **Isolate the area:** Stop people from entering the area in which the spill has occurred.

2. **Wear PPE:** Workers must know how to properly use PPE. Gloves, safety glasses, and aprons are required no matter what the spill. Additional PPE may be required.

3. **Immediately confine the spill:** When liquids escape, manufacturers of spill kits recommend using absorbent socks or non-absorbent dikes.

4. **Stop the spill:** Once the socks or dikes are in place, determine the source of the leak. If it's a drum, turn it upright or roll it so that a puncture is on top rather than on the bottom. If a valve can be placed to stop the spill, employ it or another temporary repair.

5. **Clean the Spill:** Cleanup typically starts at the center after all liquid has been absorbed. Work outward so that the socks or dikes are the last items removed and packed in the spill kit barrels.

6. **Decontamination:** Decontamination involves more than packing up the material from the spill and storing it until it can be properly removed from the scene. People and all equipment must be decontaminated, including properly cleaning respirators, if used.

7. **Record the spill:** Record keeping is legally required and the spill may have a long term effect. State agencies and the EPA require certain types of spills to be reported by phone. Both state and federal OSHA require that any incident which results in a worker death or in-patient hospitalization of three or more people be reported within eight hours. If someone has a heart attack during spill cleanup, even if that worker was not involved, it must be reported to OSHA by phone. An incident report should be completed.

8. **Evaluate:** Evaluate what worked and what didn't. Replace spill kits, ordering them whole from the manufacturer. Spill kits at LMC provide a barrel or container for the used spill absorbent materials. Monitor the workers who cleaned up the spill for any potential exacerbation of health issues.

b. Incidental Spills

If you are unsure of the hazardous nature of a spill or need assistance with selection of PPE, contact the CHO prior to any attempt at cleaning up the spill. Only those people who have been properly trained and have the appropriate spill cleanup kits and PPE should conduct cleanup of incidental spills. Training will be provided by the CHO. In the event of an incidental spill, do the following:

- Assess the hazard.
- Wear appropriate PPE. At a minimum, this requires gloves, lab coat, and safety glasses/goggles.
- Isolate/barricade the affected area.
- Notify a coworker that you are cleaning up the spill.
- Neutralize strong acids and bases.
- Contain and clean up the spill with approved cleanup kits located either in the laboratory or in a stockroom.
- Temporarily place contaminated cleanup materials containing volatile solvents or chemicals in a fume hood or put them in buckets for disposal.
- Dispose of all chemical spill cleanup material as hazardous waste.
- Write a brief report describing how the spill occurred and the cleanup procedures used. Send a copy to your supervisor and to the CHO.
- If you are not trained to cleanup spills, call the CHO at LMC extension 8773. Remain at the scene to serve as a resource.

c. Mercury Spills

Mercury vapors are highly toxic. Requiring the use of non-mercury containing items can minimize mercury spills. All spills of mercury, no matter how small, are considered toxic and must be cleaned up by a trained employee. All collected mercury must be disposed of as hazardous waste. In the event of a mercury spill, do the following:

1. Isolate/barricade the area.
2. Call Facilities Management 6-911.
3. Remain at the scene to serve as a resource.
4.

7.2 Personal Chemical Exposure

Chemical exposure can lead to irritation or burns of the skin, eyes, throat, and lungs, dizziness, headaches, disorientation or unconsciousness, or damage to internal organs.

If your eyes get splashed with a chemical:

1. Immediately flush them in the nearest eyewash fountain for 15 minutes.
2. Keep your eyes open while washing them.
3. Seek medical attention.

If your skin comes into contact with a chemical:

1. Flush the area with water for 15 minutes and remove contaminated clothes.
2. If large areas are exposed, use an emergency chemical shower. Begin flushing affected area or persons with water immediately and remove clothes while using shower. Continue flushing with water for 15 minutes.
3. Seek medical attention.

If you inhale a chemical, immediately move to fresh air. Seek medical attention.

If you ingest a chemical, you may or may not induce vomiting depending on the chemical. Refer to the SDS/MSDS for recommended first aid. Never induce vomiting when corrosives are ingested. Seek medical attention.

7.3 Detection of Chemical Odors

The human nose cannot and should not be relied on as an adequate warning device against chemical hazards. Some materials, such as hydrogen sulfide, can cause olfactory fatigue rendering the sense of smell useless as a warning device. Alternatively, some materials are very odorous and thus have good warning properties. In either case, if a release or spill is suspected, immediately secure any operating equipment and leave the area. Call 6-911. Do not return to the area until given the approval to do so.

7.4 Fire

In the event of a fire, do the following:

1. Instruct all personnel to evacuate the facility, clearing the area of all personnel.
2. Activate the fire alarm pull station.
3. Press the emergency gas shut-off switch.
4. If it can be done safely, and if you are trained in the use of a fire extinguisher, LMC employees, but *NOT* students may attempt to extinguish the fire using a portable fire extinguisher. Use the PASS system when using any fire extinguisher in a fire situation.

   P = Pull : Pull the fire extinguisher pin

   A = Aim: Aim the nozzle at the base of the fire

   S = Squeeze: Squeeze the handle

   S = Sweep: Sweep the base of the fire from side to side

5. Confine the fire by closing doors as you leave the area.
6. If you can safely do so, advise emergency personnel on the nature of the fire.
7. Make sure those under your supervision are accounted for.

7.5 Utility Failure

The interruption of any utility service either scheduled or from natural causes, is considered an emergency event. A building evacuation may be required.

- If the ventilation system shuts down, cease any operations in ventilated areas.
- Close and secure all chemical containers.
- Loss of water can affect cooling systems. Shut down any procedure using circulating cooling water.
- Shut down ovens and kilns in the event of the loss of gas service. Notify Facilities Management before restarting the equipment. Do not use any ignition sources before the pilot lights have been lit.

7.6 Reporting Injuries

If anyone needs emergency medical attention, call 9-911 from a campus phone or 911 from a cell phone. Indicate the nature of the problem, your location, and identifying information.

8.0 SPECIFIC CHEMICAL HAZARDS

The Laboratory Standard specifies the Chemical Hygiene Plan shall include provisions for additional employee protection for work with particularly hazardous substances. This section addresses these specific considerations. Each Department is responsible for developing Standard Operating Procedures (SOPs) that are appropriate for their chemical use.

8.1 Particularly Hazardous Substances

The use of select carcinogens, reproductive toxins, and substances that have a high degree of acute or chronic toxicity requires a written standard operating procedure. The procedure must include the establishment of a designated area with appropriate signs warning of the hazards associated with the substance, the use of a fume hood or equivalent containment device, procedures for decontaminating the designated area, and procedures for safe removal of contaminated waste. In all cases, make sure to consult the SDS/MSDS to determine if a chemical meets the definition of a particularly hazardous substance.

A. Definitions

Particularly hazardous substances, by MIOSHA definition, are select carcinogens, reproductive toxins, 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 1 carcinogens. Also included are chemicals or processes listed in either Group 2A or 2B by IARC or under the category “reasonably anticipated to be carcinogens” by NTP and that cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

- 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.
- After repeated skin application of less than 300 mg/kg of body weight per week.
- After oral dosages of less than 50 mg/kg of body weight per day.

Reproductive Toxins 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). Information on reproductive effects will be listed on the SDS/MSDS.

Chemicals with a high degree of acute and chronic toxicity are not defined in the Laboratory Standard. Therefore, the MIOSHA Hazard Communication definition of a highly toxic chemical will be used. 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 LD_{50} is that dose at which a lethal response is observed in 50% of the test animals. The hazard(s) of a chemical may also be listed on its container label. Additionally, if the hazard of a chemical is not evident from the container label, the SDS/MSDS will list the specific hazards. Use the SDS/MSDS to address chronic toxicity.

For further help in determining the hazard of a chemical, contact your supervisor or the CHO.

B. Designated areas

Work with these categories of chemicals must be conducted in a designated area. Designated areas may include a hood, glove box, portion of a laboratory, or entire laboratory room. Post signs on designated areas and clearly mark/define the boundaries.

C. Guidelines/procedures for employees working in designated areas

Employees shall:

- Be trained to work with these highly toxic chemicals.
- Use the smallest amount of chemical that is practical.
- Decontaminate a designated area when work is completed.
- Prepare wastes in accordance with the Resource Conservation and Recovery Act (RCRA) and as designated by the CHO.
- Store these chemicals in locked and enclosed spaces with a slight negative pressure compared to the room.
- Not wear jewelry in designated areas.
- Wear eye protection and long-sleeved disposable clothing and gloves known to resist permeation by the chemicals to be used.

8.2 Toxic Chemicals

The recommended exposure limits or OSHA-mandated limits can be found in the SDS/MSDS for most of the chemicals used in the laboratory. These limits are expressed as threshold limit values (TLV), permissible exposure limits (PEL), short term exposure limits (STEL), ceilings (C), and action levels. These limits help to serve as guidelines for determining the appropriate safety precautions to be taken when handling specific chemicals.

Wear eye protection, long sleeves, and gloves known to resist permeation by the chemicals to be used when handling toxic chemicals. Chemicals must be used in an operating fume hood, glove box, vacuum line, or similar device which is equipped with appropriate traps and/or scrubbers under the following conditions (if this equipment is not available, then no work shall be performed using that chemical):

- When a TLV or PEL value is less than 50 ppm or 100 mg/m^3.

- When the animal or human median inhalation lethal concentration, LC_{50}, is less than 200 ppm or 2000 mg/m^3 when administered continuously for one hour or less (this condition is followed if a TLV, PEL, or comparable value is not available for that chemical).

- When laboratory handling of a chemical with a moderate or greater vapor pressure will be likely to exceed air concentration limits.

8.3 Corrosive Chemicals and Contact-Hazard Chemicals

A chemical is defined as being corrosive if it meets one of the following definitions:

- Fits the OSHA definition of corrosive in Appendix A of 29 CFR 1910.1200 (a chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.).

- Fits the EPA definition of corrosive in 40 CFR 261.22 (has pH greater than 12 or less than 2.5).

- Is known or found to be corrosive to living tissue.

Acids and alkalis, for example, are known to be corrosive to living tissue. A contact-hazard chemical is an allergen or sensitizer that is identified as such per the SDS/MSDS or label or in medical or industrial hygiene literature or is known to be an allergen or sensitizer.

Take the following precautions when working with corrosive chemicals and contact-hazard chemicals:

- Always wear proper PPE, especially eye protection (items may include safety goggles and face shield, gloves known to be resistant to permeation or penetration, laboratory aprons, laboratory coats).
- Add acids and alkalis to water; never add water to acids or alkalis.
- Add acid to water slowly, as a great deal of heat will be formed.
- Provide secondary containment for storage bottles unless bottles are PVC-coated.
- Treat any accident resulting in contact with the skin immediately. Wash affected area with large amounts of water for at least 15 minutes. Seek immediate medical attention for chemical burns resulting from concentrated solutions.
- Always separate and store acids, alkalis, and other corrosive materials below eye level in properly labeled storage cabinets.
- Store acids away from cyanides.
- Store acids and bases away from flammable liquids and solvents.
- Inspect containers frequently for corrosion.
- Minimize quantities used according to your application.

8.4 Reactive Chemicals

Chemicals or combinations of chemicals that react violently or explosively, releasing a large amount of energy are referred to as reactive. This type of chemical may also produce toxic or flammable vapors.

A chemical is classified as being reactive if it:

- Is described as such in the SDS/MSDS.
- Is ranked by the NFPA as a 3 or 4 for reactivity.
- Is identified by the DOT as an oxidizer, organic peroxide, or a class A, B, or C explosive.
- Fits the EPA definition of a reactive solid in 40 CFR 261.23.
- Fits the OSHA definition of unstable in 29 CFR 1910.1450.

A reactive chemical is characterized by any of the following:

- Readily undergoes violent change without detonating.
- Reacts violently with water.
- Generates toxic gases or vapors sufficient to endanger human health or the environment when mixed with water.
- Is sulfide or cyanide bearing and generates toxic gases or vapors when exposed to pH conditions between 2.0 and 12.5.
- Is capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
- Is a chemical in pure state that will vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, or temperature.

Water reactive substances react with water to evolve heat and flammable or explosive gases. Some examples include the following:

- Potassium metal
- Aluminum alkyls (polymerization catalysts)
- Lithium Aluminum Hydride
- Sodium metal

Pyrophoric substances will not only react rapidly with oxygen in high concentrations, but even with the oxygen in air. Some examples include the following:

- White Phosphorus
- Boron hydride gas
- Finely powdered Iron Disulfide

Handle all reactive chemicals with extreme care and store them away from incompatible chemicals. Always wear proper PPE while handling reactive chemicals.

8.5 Explosives

Explosives can be defined as chemicals that can result in an explosion, or an extremely rapid and violent decomposition producing large volumes of gas. Explosives can be categorized as high explosives (result in detonations that occur in millionths of a

second) and low explosives (result in deflagrations which are rapid burning). Some examples of explosive chemicals include the following:

- Ammonium Nitrate
- Benzoyl Peroxide (explosion-sensitive to shock, heat, and friction)
- Picric acid
- Sodium Azide

Many chemicals form highly explosive compounds when mixed. Others become highly explosive when allowed to decompose or when exposed to air. Handle chemicals that are known to be potentially explosive with extreme care while wearing proper PPE. When working with these chemicals, make safe handling techniques the number one priority to prevent any accidental mishaps.

8.6 Organic Peroxides or Peroxide-Forming Chemicals

Organic peroxides and peroxide formers are very unstable explosives. They are extremely sensitive to shock, sparks, heat, or other forms of accidental explosive initiation. Substances can form peroxides upon standing or when in contact with air. After peroxides form, they may dry in the threads on the container's top or may become concentrated if the chemical is distilled. Dry or concentrated peroxides formed in this manner are highly explosive. Some examples include the following:

- Aldehydes
- Ethers, especially cyclic ethers, and ethers derived from primary and secondary alcohols (Ethyl ether, Isopropyl ether)
- Most alkenes (Cyclohexene, Cyclooctene)
- Vinyl and vinylidene compounds (Vinyl Acetate, Vinylidene Chloride)

Label all peroxide-forming chemicals with the date the container was received from the supplier and the date the container was first opened, even if the chemical contains inhibitors to retard peroxide formation. Use or dispose of any peroxide-forming chemical prior to the expiration date.

All peroxide-forming chemicals have a limited shelf life, whether the container is opened or not. Listed below are two categories for storing such chemicals. Storage past these limits is discouraged, as highly explosive compounds are likely to form. Storage limits start when the chemical is first received, regardless of opening. If in doubt of the stability of the chemical, do not move it until you have received directions from the CHO. **Dried crystals or residue are indications of a highly explosive state.**

Group “A” Peroxidizable Compounds – 3-month storage limit

Divinylacetylene	Sodium amide
Di-isopropyl ether	Vinylidene chloride
Potassium metal	

Group “B” Peroxidizable Compounds – 1 year storage limit

Acetal	Ethylene glycol dimethyl ether
Acrylic acid	Ethyl vinyl ether
Acrylonitrile	Methyl acetylene
1,3-butadiene*	Methyl cyclopentane
1,3-butadiyne	Methyl isobutyl ketone
2-butanol	2-propanol
Chloroprene*	Styrene
Chlorotrifluoroethylene	Tetrafluoroethylene*
Cumene	Tetrahydrofuran
Cyclohexene	Tetrahydronaphthalene (tetralin)
Decahydronaphthalene (decalin)	Vinyl acetate
Dicyclopentadiene	Vinylacetylene
Diethylene glycol	Vinyl chloride
Diethyl ether	Methyl methacrylate
P-dioxane	Vinylpyridine
Divinyl ether	

*When stored as a liquid, the peroxide-forming potential increases. Butadiene, Chloroprene, and Tetrafluoroethylene should be considered List “A” compounds when stored as liquids.

References:

University of Nevada at Reno; author, Richard Foreman; http://unr.edu/homepage/rforeman/percom.html

National Safety Council Newsletter; author, John F. Belta, IUPUI

Bretherick’s Handbook of Reactive Chemical Hazards, 5th edition

8.7 Flammable and Combustible Liquids

Liquids form vapors which are usually denser than air, and thus tend to settle. The tendency of a liquid to ignite is measured by a test in which the liquid is heated and periodically exposed to a flame until the mixture of vapor and air ignites at the liquid's surface. The temperature at which this occurs is called the flash point. A flammable liquid has a flash point below 37.8°C (100°F). A combustible liquid has a flash point above 37.8°C (100°F). Consult the chemical label or SDS/MSDS to determine the flash point of a chemical. OSHA divides flammable liquids into classes IA, IB, and IC and combustible liquids into classes II, IIIA and IIIB. Note the following storage precautions when working with flammable and combustible liquids:

- Keep flammable and combustible liquids in appropriate containers and store them in flammable liquid storage cabinets or in vented cabinets at floor level away from any possible heat source.

- Keep solvents in safety cans. Drums and five-gallon containers are not allowed in laboratories unless stored in a flammable liquid cabinet and used with smaller safety cans for dispensing.

- Store flammable solvents requiring refrigeration in refrigerators/freezers engineered with no internal components which could trigger an explosion.

- Do not store flammable or combustible liquids, including waste stock, in exits and stairways.

- Use safety cans whenever possible.

- Do not store a total of more than 10 gallons of flammable liquids per laboratory outside of a storage cabinet or storage room, except in safety cans.

- Do not store a total of more than 25 gallons of flammable liquids in safety cans per laboratory outside of a storage cabinet or storage room.

- Do not store a total of more than 60 gallons of combustible liquids in safety cans per laboratory outside of a storage cabinet or storage room.

Flammable liquids are divided into the following three classes:

Class	Flash Point	Boiling Point	Examples
IA	<73°F (22.8°C)	<100°F (37.8°C)	Diethyl ether, Pentane
IB	<73°F (22.8°C)	>=100°F (37.8°C)	Acetone, Ethanol
IC	>=73°F (22.8°C) <100°F (37.8°C)		Styrene, Nonane, Xylenes

Combustible liquids are divided into the following three classes:

Class	Flash Point	Examples
II	>=100°F (37.8°C) <140°F (60°C)	N,N-dimethylformamide
IIIA	>=140°F (60°C) <200°F (93.3°C)	Dodecane, Aniline
IIIB	>200°F (93.3°C)	Ethylene glycol, Mineral Oil

Maximum allowable container capacity for flammable and combustible liquids:

Container	IA	IB	IC	II	III
Glass	1 pint	1 quart	1 gallon	1 gallon	5 gallons
Metal/Approved Plastic	1 gallon	5 gallons	5 gallons	5 gallons	5 gallons
Safety Can	2 gallons	5 gallons	5 gallons	5 gallons	5 gallons

Exception: Glass containers up to one gallon in size are permitted for storage of flammable liquids if the required purity would be adversely affected by storage in a metal or approved plastic container, or if the liquid would cause excessive corrosion or degradation of the metal or approved plastic container.

When using flammable or combustible liquids:

- Avoid handling the liquids around open flames.
- Handle only appropriate quantities of liquids at any given time.

- Handle only in well-ventilated areas.
- Keep containers, beakers, etc. closed or covered when possible, to avoid release of flammable vapors.
- Never use an open flame for heating flammable solvents.
- Evaporate large quantities of liquids in a contained system that will minimize escape of material.
- Keep hot plates and water baths at a moderate heat setting.
- Do not fill flasks more than half-full and use boiling chips when heating.

Some examples of flammable liquids are the following:

- Acetaldehyde
- Acetone
- Acetonitrile
- Acrylonitrile
- Allyl alcohol
- N-amyl acetate
- Sec-amyl acetate
- N-amyl alcohol
- Tert-amyl alcohol
- Benzene
- 1-butanol (n-butanol)
- Tert-butyl alcohol
- Carbon disulfide
- Chlorobenzene
- Cyclohexane
- Cyclohexene
- 1,1- and 1,2-dichloroethane
- Diethyl ether
- 1,1- and 1,2-dimethylhydrazine
- Dioxane
- Ethanol
- Ethyl acrylate
- Ethylenediamine
- Ethyl formate
- Gasoline
- N-heptane
- N-hexane
- Isoamyl alcohol
- Isobutyl alcohol (isobutanol)
- Isopropyl acetate

- Isopropyl alcohol
- Methanol
- Isopropylamine
- Methyl ethyl ketone
- Morpholine
- Nitromethane
- 2-nitropropane
- Pentane
- Propylene oxide
- Pyridine
- Toluene
- Triethylamine
- Vinyl acetate
- Xylene

8.8 Oxidizers

Oxidizers are defined as substances that stimulate the combustion of organic matter. These chemicals spontaneously evolve oxygen either at room temperature or under slight heating. They can react vigorously at ambient temperatures when stored near or in contact with organic compounds. Some examples include the following:

- Chlorate compounds (potassium chlorate)
- Permanganate compounds (potassium permanganate)
- Nitrate compounds (potassium nitrate, uranyl nitrate, zinc nitrate)
- Acid dichromate
- Chromic acid
- Chromium trioxide
- Hydrogen peroxide (>30%)
- Nitric acid
- Sodium peroxide
- Sulfuric acid
- Chlorine gas
- Manganese dioxide
- Perchloric acid (see section j)
- Potassium nitrite

Store oxidizers away from flammable/combustible liquids and other combustible materials. Store compressed gas cylinders of oxygen at least 20 feet from flammables or separate by a firewall.

8.9 Perchloric Acid

Perchloric acid is an extremely hazardous and powerful oxidizing agent. Contact with combustible materials (wood, paper, grease, oil and most organic compounds) can cause these materials to become extremely flammable, and they may explode spontaneously or with impact, friction, or heating. Fumes from perchloric acid may form explosive metal perchlorates in fume hoods causing explosions. This chemical requires special precautions when handling. The following rules apply to the use of perchloric acid:

- Use of perchloric acid is restricted to specially designed perchloric acid hoods.
- Use of perchloric acid requires the approval of the Safety Coordinator and a peer review group.
- Use of perchloric acid requires a standard operating procedure along with special training on the specific safety hazards that are present with the use of perchloric acid.

8.10 Picric Acid

Picric acid (trinitrophenol) is explosive when it is dry. Dry picric acid is more explosive than TNT. Picric acid in a solution of at least 10% water is considered flammable but not explosive. Picric acid in a solution less than 10% water is considered explosive and should not be handled. Dry picric acid can accumulate on the outer surface of the container or in cap threads. Dry picric acid in cap threads is not always visible and can present a significant friction-sensitive hazard. Extreme caution should be given to containers with metal caps containing any solution of picric acid. Shock-sensitive picrates are formed when picric acid vapors come in contact with metals such as copper, lead or zinc. Contact with concrete floors can also form sensitive calcium picrate salts. Extreme caution should be exercised when encountering bottles of picric acid with the following characteristics:

- Little or no moisture content within the bottle.
- A metal cap on the container.
- Any observable needle-like structures within the container.
- Any sign of accumulation on the surface of the bottle.

In any of these cases, contact the CHO and facilities management immediately, and do not attempt to move the container. Qualified safety personnel with appropriate safety equipment will move it. This container is highly explosive.

8.11 Formaldehyde

Formaldehyde is a colorless gas that has a bitter odor. Formalin is an aqueous solution containing 37-50 percent formaldehyde. Overexposure to formaldehyde can lead to serious health concerns. The Michigan Department of Public Health adopted the Formaldehyde Standard in 1993. This standard was established to minimize exposures to formaldehyde and provide a safe work environment. The standard establishes a 0.75 ppm permissible exposure limit (PEL), 2.0 ppm short term exposure limit (STEL) and a 0.5 ppm action limit. The standard requires exposure monitoring and enrollment in the medical surveillance program for employees exposed above the action level or STEL.

Exposure to formaldehyde can occur through inhalation, ingestion, skin contact or contact with body openings such as the eyes and nose. Follow these guidelines when working with formaldehyde:

- Wear proper PPE as determined from the standard operating procedures developed for each procedure involving formaldehyde.
- Minimize exposures using engineering controls and workplace practices.
- If required, participate in the medical surveillance program.

Contact the CHO for exposure monitoring of all procedures where formaldehyde is used outside of a fume hood. For areas where exposure monitoring has been conducted and levels are found to be above the PEL or STEL, the area must be posted with the following information:

- **DANGER**
- **FORMALDEHYDE**
- **IRRITANT AND POTENTIAL CANCER HAZARD**
- **AUTHORIZED PERSONNEL ONLY**

Label receptacles containing formaldehyde as follows:

- **FORMALDEHYDE**
- **POTENTIAL CANCER HAZARD**

8.12 Benzene

Benzene is a colorless to light yellow liquid with an aromatic odor. It is flammable and is a known human carcinogen and a possible reproductive toxin. It can be found as either a liquid or a vapor and has a high evaporation rate. Because of this high evaporation rate, benzene liquid can quickly vaporize, generating increased concern for respiratory and fire hazards. Michigan adopted the Benzene Standard in 1989 to minimize exposures to benzene. This standard establishes a 1.0 ppm PEL, 5 ppm STEL and a 0.5 ppm action limit. The standard requires exposure monitoring and enrollment in the

medical surveillance program for employees exposed to benzene above the action level. Follow these guidelines when working with benzene:

- Wear proper PPE as determined from the standard operating procedures developed for each procedure involving the use of benzene.

- Minimize exposure using engineering controls and workplace practices.

- If required, participate in the medical surveillance program.

Contact the CHO for exposure monitoring of all procedures where benzene is used outside of a fume hood. In areas where exposure monitoring has been conducted and levels are found to be above the PEL or STEL, the area must be posted with the following information:

- **DANGER**
- **BENZENE**
- **CANCER HAZARD**
- **AUTHORIZED PERSONNEL ONLY**

Label receptacles containing benzene as follows:

- **DANGER**
- **CONTAINS BENZENE**
- **CANCER HAZARD**

8.13 Liquid Nitrogen

Safety Hazards Associated with Handling Liquid Nitrogen:

- The extremely low temperature of the liquid can cause **severe frostbite or eye damage** upon contact. Items in contact with liquid nitrogen become extremely cold. Touching these items may result in torn flesh. Many substances become brittle upon contact with liquid nitrogen and may shatter when cold (such as common glass and large solid plastics), sending pieces of the material flying.

- On vaporization it expands by a factor of 700; one liter of liquid nitrogen becomes 24.6 cubic feet of nitrogen gas. This can cause **explosion** of a sealed container. This release of nitrogen can also displace oxygen in the room and cause **asphyxiation** without warning.

- Because the boiling point of oxygen is above that of nitrogen, oxygen can condense from the air into the liquid nitrogen. If insulated flasks containing liquid nitrogen are left uncovered for an extended period of time, liquid oxygen can

build up to levels which may cause **violent reactions** with organic materials (i.e. a severe clothing fire could result).

Personal Protective Equipment (PPE) Required When Handling Liquid Nitrogen:

1. **Safety goggles (unvented)** – Required at all times.
2. **Face shield** – Required when pouring or filling.
3. **Insulating gloves** (gloves should be loose fitting, so they can be thrown off if liquid pours inside them, or they should be elastic cuff insulated gloves). – Required when pouring or filling.
4. **A lab coat or long sleeves** is required to minimize skin contact. Also, trousers should be worn on the outside of boots or work shoes to prevent shoes filling in the event of a spillage. – Required when pouring or filling.

Rules and Precautions for Handling Liquid Nitrogen:

1. You must have approval prior to handling liquid nitrogen.
2. Always wear PPE when handling liquid nitrogen.
3. Use liquid nitrogen only in well ventilated places. Never dispose of liquid nitrogen by pouring it on the floor. It could displace enough oxygen to cause suffocation. Nitrogen is colorless and odorless – the cloud that forms when you pour liquid nitrogen is condensed water vapor from the air, not nitrogen gas.
4. Do not allow any liquid nitrogen to touch any part of your body or become trapped in clothing near the skin.
5. Do not touch any item that has been immersed in liquid nitrogen until it has warmed to room temperature.
6. Do not store liquid nitrogen in any container with a tight fitting lid. A tightly sealed container will build up pressure as the liquid boils and may explode after a short time. Use only approved unsealed containers. Do not store liquid nitrogen for long periods in an uncovered container. Use only fittings that have been designed specifically for use with cryogenic liquids as non-specialized equipment may crack or fail.
7. **Never ride in an elevator with liquid nitrogen.** This applies to the delivery person as well as LMC personnel. When using passenger elevators, use an elevator key to prevent the door from being opened by unauthorized persons. If a key is not available, then station a person at each floor to ensure no one enters.

8. Always use a team of personnel to transport liquid nitrogen. Failure of a container or a large spillage could result in asphyxiation at a time when you are unlikely to be found or able to get assistance.

9. Always make sure that containers of liquid nitrogen are suitably vented and unlikely to block due to ice formation.

10. Do not fill cylinders to more than 80% of capacity, since expansion of gases during warming may cause excessive pressure buildup.

APPENDIX A

Link to MIOSHA part431 Hazardous Work in Laboratories
http://www.michigan.gov/documents/CIS_WSH_part431_35623_7.pdf

APPENDIX B

Link to MIOSHA part 350 Carcinogens

http://www.michigan.gov/documents/CIS_WSH_part350_42558_7.pdf

APPENDIX C

SDS and MSDS

SDS (Safety Data Sheets), formerly known as MSDS (Material Safety Data Sheets), is a summary of the health hazards of a material and associated recommended safe work practices. SDS/MSDS are required by OSHA to be sent by chemical manufacturers to the purchasers of their chemicals.

To work in a lab, OSHA states you should:

- **Be aware of what an SDS/MSDS is, and its relevance to your health and safety**
- **Be aware of how to access SDS/MSDS for your work area**
- **Maintain any SDS/MSDS that are received with incoming chemical shipments and ensure that they are readily accessible to lab employees during each work shift when they are in their work area(s). Electronic access is acceptable with a printer.**

APPENDIX D

Definitions for SDS/MSDS

Action Levels: Levels of exposure (concentration in air) at which OSHA regulations for protective programs must be put into effect.

Acute Toxicity: Ability of a substance to cause poisonous effects resulting in severe biological harm or death soon after a single exposure or dose.

Ambient: Encompassing atmosphere.

American Conference of Governmental Industrial Hygienists (ACGIH): Professional organization devoted to worker health protection and develops threshold limit values for chemical substances.

American National Standards Institute (ANSI): Body of various trade, technical, professional, and consumer groups whom develop voluntary ANSI standards.

American Society for Testing and Materials (ASTM): Voluntary membership organization with members from a broad spectrum of individuals and agencies that sample and test methods on materials to determine the health and safety aspects of materials, safe performance guidelines, and effects of physical and biological agents and chemicals.

Article: Manufactured item other than fluid or particle: (i) which is formed to a specific shape or design during manufacture; (ii) which has end use function(s) dependent in whole or in part upon its shape or design during end use; and (iii) which under normal conditions of use does not release more than very small quantities, e.g., minute or trace amounts of a hazardous chemical and does not pose a physical hazard or health risk to workers.

Carcinogen: A chemical is considered a carcinogen if:

- It has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen,
- It is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition),
- It is regulated by OSHA as a carcinogen.

CAS Number: Identification number assigned by the Chemical Abstracts Service (CAS) of the American Chemical Society.

Chemical: Any element, chemical compound, or mixture of elements and/or compounds.

Chemical Transport Emergency Center (CHEMTREC): A national center established by the Chemical Manufacturers Association (CMA) to relay pertinent emergency information concerning specific chemicals on request; 1-800-424-9300.

Closed Cup (cc): Method used in flash point testing.

Chronic Toxicity: Capacity of a substance to cause long-term poisonous human health effect.

Code of Federal Regulations (CFR): Collection of rules and regulations originally published in the Federal Register by various governmental departments and agencies.

Combustible Liquid: 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 or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Common Name: Any designation or identification such as code name, code number, trade name, brand name or generic name used to identify a chemical other than by its chemical name.

Container: Any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For purposes of this section, pipes or piping systems, and engines, fuel tanks, or other operating systems in a vehicle, are not considered to be containers.

Corrosive: Causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. For example, a chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the U.S. Department of Transportation in appendix A to 49 CFR part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term shall not refer to action on inanimate surfaces.

DOT: Federal Department of Transportation

Employer: A person engaged in a business where chemicals are either used, distributed, or are produced for use or distribution, including a contractor or subcontractor.

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

Extremely Hazardous Substances: The 406 chemicals identified by EPA on the basis of toxicity and listed under SARA Title III.

FFDCA: Federal Food, Drug, and Cosmetic Act.

Flammable: A chemical that falls into one of the following categories:

- Aerosol, flammable - an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening.
- Gas, flammable - (A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% 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% by volume, regardless of the lower limit.
- Liquid, flammable - 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% or more of the total volume of the mixture.
- Solid, flammable - a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

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

- 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,
- 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,
- Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).
- Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous Chemical: Any chemical that is a physical hazard or a health hazard.

HCS: Hazard Communication Standard found in 29 CFR 1910.1200.

Health Hazard: A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed workers. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.

Highly Toxic: Chemical falling within any of the following categories:

- Chemical that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each,
- Chemical that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each,
- Chemical that has a median lethal concentration (LC50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

IDLH (Immediately Dangerous to Life and Health): Maximum level to which a healthy individual can be exposed to a chemical for 30 minutes and escape without suffering irreversible health effects or impairing symptoms.

Irritant: Chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of 16 CFR 1500.41 for four hours exposure or by other appropriate techniques, it results in an empirical score of five or more. A chemical is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate
Techniques.

Label: Any written, printed, or graphic material displayed on or affixed to containers of hazardous chemicals.

Lethal Concentration (LC50): Concentration in air of a toxic substance required to cause the death of half the test animal population under controlled administration.

Lethal Dose 50 (LD50): Dose or amount of toxic substance required to cause death in half the test animal population under controlled administration.

Material Safety Data Sheet (MSDS): Written or printed material concerning a hazardous chemical.

Mixture: Any combination of two or more chemicals if the combination is not, in whole or in part, the result of a chemical reaction.

National Institute for Occupational Safety and Health (NIOSH): Federal agency involved in research on health effects due to workplace exposures and is responsible for testing and certifying respirators.

Organic Peroxide: An organic compound that contains the bivalent -O-O-structure and which may be considered a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer: 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.

Permissible Exposure Limit (PEL): Maximum air contaminant concentration a worker can be exposed to on a repeated basis without developing adverse effects.

Physical Hazard: Chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water reactive.

Ppb: Parts per billion.

Ppm: Parts per million.

Pyrophoric: Chemical that will ignite spontaneously in air at a temperature of 130 deg. F (54.4 deg. C) or below.

Safety Data Sheet: GHS compliant information concerning a hazardous material (see also: MSDS).

Sensitizer: Causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

Specific Chemical Identity: Chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.

Threshold Limit Value (TLV): Air concentrations of chemical substances to which it is believed that workers may be exposed daily without adverse effects.

Threshold limit value (TLV): Ceiling limit - ceiling exposure limit or concentration that should not be exceeded even instantaneously.

Toxic: A chemical falling within any of the following categories:

- Chemical that has a median lethal dose LD50 of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each,
- Chemical that has a median lethal dose LD50 of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each, · chemical that has a median lethal concentration LC50 in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Trade secret: Any confidential formula, pattern, process, device, information or compilation of information that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it.

TSCA: Toxic Substances Control Act.

Unstable (reactive): Chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive: Chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Work area: Room or defined space in a workplace where hazardous chemicals are produced or used, and where workers are present.

Workplace: Establishment, job site, or project, at one geographical location containing one or more work areas.

APPENDIX E

DEFINITIONS

ACGIH: The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLV's) for hundreds of chemicals, physical agents, and includes Biological Exposure Indices (BEI).

Action Level: A concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Acute: Severe, often dangerous exposure conditions in which relatively rapid changes occur.

Acute Exposure: An intense exposure over a relatively short period.

Acute Toxic Chemical: A chemical is toxic if it has the ability to produce an unwanted effect after reaching a sufficient concentration at a certain site in the body. The chemical is acutely toxic when the unwanted changes occur quickly after exposure.

ANSI: The American National Standards Institute is a voluntary membership organization (run with private funding) that develops national consensus standards for a wide variety of devices and procedures.

Asphyxiant: A chemical (gas or vapor) that can cause unconsciousness or death by suffocation. Simple asphyxiants such as nitrogen either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

Biological Hazard, Class 2: Agents of ordinary hazard including agents that may produce disease of varying degrees of severity through accidental inoculation, injection or other subcutaneous penetration, but which can usually be adequately and safely contained by ordinary laboratory techniques.

"**C**" or **Ceiling:** A description usually seen in connection with a published exposure limit. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value:Ceiling (See also Threshold Limit Value).

C.A.S. Number: Identifies a particular chemical by the Chemical Abstracts Service, a service of the American Chemical Society that indexes and compiles abstracts of worldwide chemical literature called "Chemical Abstracts."

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

Chemical Hygiene Plan (CHP): A written program developed and implemented by the department which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting students, instructors and other personnel from the health hazards presented by the hazardous chemicals used in that particular workplace.

Chronic Exposure: A prolonged exposure occurring over a period of days, weeks, or years.

Combustible: According to the DOT and NFPA, COMBUSTIBLE liquids are those having a flash point at or above 100deg.F (37.8o C), or liquids that will burn. They do not ignite as easily as flammable liquids. However, combustible liquids can be ignited under certain circumstances, and must be handled with caution. Substances such as wood, paper, etc., are termed “Ordinary Combustibles."

Compressed Gas – is a gas or mixture of gases that, in a container, will have an absolute pressure exceeding 40 psi at 70°F (21.1°C) or an absolute pressure exceeding104 psi at 130°F (54.4°C), regardless of the pressure at 70°F. It may also be a liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C).

Corrosive: A substance that, according to the DOT, causes visible destruction or permanent changes in human skin tissue at the site of contact or is highly corrosive to steel.

Designated Area: An area that may be used for work with “select carcinogens,” reproductive toxins or substances, which have a high degree of acute toxicity. This area may be the entire laboratory or an area under a device such as a laboratory hood.

Dilution Ventilation: See GENERAL VENTILATION.

DOT: The United States Department of Transportation is the Federal agency that regulates the labeling and transportation of hazardous materials.

Dyspnea: Shortness of breath, difficult or labored breathing.

Emergency: any occurrence, such as equipment failure, rupture of a container, or failure of control equipment, that results in an uncontrolled release of a hazardous chemical into the workplace.

EPA Number: The number assigned to chemicals regulated by the Environmental Protection Agency (EPA).

Flammable Gas: A gas that, at an ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or, a gas that, at an ambient temperature and pressure forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

Flammable Liquid: According to the DOT and NFPA, a flammable liquid is one that has a flash point below 100deg.F. (See FLASH POINT).

Flammable Solid: A solid, other than a blasting agent or explosive, 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 it creates a serious hazard.

Flash Point: The lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture and burn when a source of ignition (sparks, open flames, etc.) is present. Two tests are used to determine the flashpoint: open cup and closed cup. The test method is indicated on the SDS/MSDS after the flash point.

Fume: A solid particle that has condensed from the vapor state.

Gas: Chemical substances that exist in the gaseous state at room temperature.

General Ventilation: Also known as general exhaust ventilation, this is a system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are highly toxic, when there may be corrosion problems from the contaminant, when the worker is close to where the contaminant is being generated, and where fire or explosion hazards are generated close to sources of ignition (See LOCAL EXHAUST VENTILATION).

Hazardous Material: Any chemical, biological or radiological substance for which there is significant evidence that acute or chronic health effects may occur in exposed personnel. The term "health hazard" includes chemicals that are carcinogens, toxins, irritants, corrosives, sensitizers or other agents that can damage the lungs, skin, eyes, or mucous membranes, select bio agents which can cause disease or death and a sufficient quantity of any radioactive material.

Health Hazard: defined by MIOSHA as having statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur to exposed employees.

Ignitable: A solid, liquid, or compressed gas waste that has a flashpoint of less than 140deg.F. Ignitable material may be regulated by the EPA as a hazardous waste, as well.

Incompatible: The term applied to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous reaction.

Laboratory Use of Hazardous Materials: The handling or use of hazardous materials in which the following conditions are met: (1) Chemical manipulations are carried out on a laboratory scale. (2) Multiple chemical procedures or chemicals are used. (3) The procedures involved are not part of a production process. (4) Protective laboratory practices and equipment are available and in common use to minimize the potential for personnel exposure to hazardous chemicals.
At GVSU Laboratory Use (GVSU's Definition in addition to the above)- Laboratory use or a laboratory can be a space or location where there is the use of hazardous materials. These may include (but are not limited to) Studios.

Laminar Air Flow: Air flow in which the entire mass of air within a designated space move with uniform velocity in a single direction along parallel flow lines with a minimum of mixing.

Local Exhaust Ventilation (also known as exhaust ventilation.)**:** A ventilation system that captures and removes air contaminants at the point they are being produced before they escape into the workroom air. The system consists of hoods, ductwork, a fan, and possibly an air-cleaning device. Advantages of local exhaust ventilation over general ventilation include removing the contaminant rather than diluting it; less airflow making it a more economical system over the long run; and conservation or reclamation of valuable materials. However, the system must be properly designed with the correctly shaped and placed hoods, correctly sized fans and correctly connected ductwork.

Lower Explosive Limit (LEL) (also known as Lower Flammable Limit (LFL))**:** The lowest concentration of a substance that will produce a fire or flash when an ignition source (flame, spark, etc.) is present. It is expressed in percent of vapor or gas in the air by volume. Below the LEL or LFL, the air/contaminant mixture is theoretically too "lean" to burn (See also UEL).

MSHA: The Mine Safety and Health Administration; a Federal agency that regulates the mining industry in the safety and health area.

Narcosis: Stupor or unconsciousness caused by exposure to a chemical.

NFPA: The National Fire Protection Association is a voluntary membership organization whose aims are to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 704, "Identification of the Fire Hazards of Materials." This system rates

the hazard of a material during a fire. These hazards are divided into health, flammability, and reactivity hazards and appear in a well-known diamond system using from zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard.

National Institute for Occupational Safety and Health (NIOSH): Federal agency that among its various responsibilities trains occupational health and safety professionals, conducts research on health and safety concerns, and tests and certifies respirators for workplace use.

Occupational Safety and Health Administration (OSHA): A Federal agency under the Department of Labor that publishes and enforces safety and health regulations for most businesses and industries in the United States.

Odor Threshold: The minimum concentration of a substance at which a majority of test subjects can detect and identify the substance's characteristic odor.

Oxygen Deficiency: An atmosphere having less than the normal percentage of oxygen found in normal air. Normal air contains 21% oxygen at sea level.

Permissible Exposure Limit (PEL): An exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either a time-weighted-average (TWA) exposure limit (8 hour), a 15-minute short-term exposure limit (STEL), or a ceiling (C). The PELs are found in Tables Z-1, Z-2, or Z-3 of OSHA regulations 1910.1000. (See also TLV).

Personal Protective Equipment: Any devices or clothing worn by the worker to protect against hazards in the environment. Examples are respirators, gloves, and chemical splash goggles.

Physical Hazard: A chemical that has scientifically valid evidence proving it to be a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water reactive.

RAD: The unit of absorbed dose equal to 100 ergs per gram or 0.01joules per kilogram of absorbing material.

Reactivity: A substance's susceptibility to undergoing a chemical reaction or change that may result in dangerous side effects, such as explosion, burning, and corrosive or toxic emissions. The conditions that cause the reaction, such as heat, other chemicals, and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on the SDS/MSDS.

Respirator: A device that is designed to protect the wearer from inhaling harmful contaminants.

Respiratory Hazard: A particular concentration of an airborne contaminant that, when it enters the body by way of the respiratory system or by being breathed into the lungs, results in some bodily function impairment.

Select Carcinogens: 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 1 carcinogens. Also included are chemicals or processes listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP *and* that cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

- 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 10mg/ml3.
- After repeated skin application of less than 300 mg/kg of body weight per week.
- After oral dosages of less than 50 mg/kg of body weight per day.

Sensitizer: A substance that may cause no reaction in a person during initial exposures, but afterwards, further exposures will cause an allergic response to the substance.

Short Term Exposure Limit: Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. In addition, the daily TLV-TWA must not be exceeded.

"Skin": This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the chemical through the skin and eyes. Thus, protection of large surface areas of skin should be considered to prevent skin absorption so that the TLV is not invalidated.

Threshold Limit Value: Airborne concentrations of substances devised by the ACGIH that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLV's are advisory exposure guidelines, not legal standards that are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLV's: Time Weighted Average (TLV-TWA), Short Term Exposure Limit (TLV-STEL), and Ceiling (TLV-C). (See also PEL).

Time Weighted Average: The average time, over a given work period (e.g., 8-hour workday) of a person's exposure to a chemical or an agent. The average is determined by sampling for the contaminant throughout the time. Represented as TLV-TWA.

Trade Name: The commercial name or trademark by which a chemical is known. One chemical may have a variety of trade names depending on the manufacturers or distributors involved.

Unstable (Reactive) : A chemical that, in its pure state or as commercially produced, will react vigorously in some hazardous way under shock conditions (i.e., dropping), certain temperatures, or pressures.

Upper Explosive Limit: Also known as Upper Flammable Limit is the highest concentration (expressed in percent of vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present. Theoretically, above this limit the mixture is said to be too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is1ppm and the UEL is 5ppm, then the explosive range of the chemical is 1-ppm to5ppm. (See also LEL).

Vapor: The gaseous state of substances, which are normally in the liquid or solid state (at normal room temperature and pressure). Vapors evaporate into the air from liquids such as solvents. Solvents with low boiling points will evaporate.

APPENDIX F

LMC CHEMICAL SAFETY LABORATORY CHECKLIST

Room: _____
Building: _____
Inspection Date: _____
Inspected By: _____

GENERAL

1. Emergency phone numbers are clearly posted.

   YES NO N/A

2. Warning signs are posted where needed.

   YES NO N/A

3. Right-to-Know law bulletin is posted within department.

   YES NO N/A

4. All personnel know how to obtain SDS/MSDS's.

   YES NO N/A

5. All personnel have received Lab Specific Training.

   YES NO N/A

6. All personnel have received Lab Safety Training.

   YES NO N/A

7. Lab coats are available.

   YES NO N/A

8. Chemical protective gloves are available.

   YES NO N/A

9. Safety goggles are available.

YES NO N/A

10. An eyewash fountain is present.

YES NO N/A

11. An emergency shower is present.

YES NO N/A

12. Food and Beverage are not stored or used in lab.

YES NO N/A

13. Aisles are uncluttered and without a tripping hazard.

YES NO N/A

14. Chemical spill kits are available.

YES NO N/A

15. Non-contaminated sharp objects in labeled, puncture-proof containers.

YES NO N/A

16. Fume hoods have current inspection sticker.

YES NO N/A

17. All exit ways are free and unobstructed.

YES NO N/A

18. Fire extinguishers are available and unobstructed.

YES NO N/A

19. Fire extinguishers have DPS tag and are sealed.

YES NO N/A

20. Current inventory of chemicals is available.

YES NO N/A

CHEMICAL STORAGE AND HANDLING

1. Gas cylinders are properly secured.

   YES NO N/A

2. No leaking containers are present.

   YES NO N/A

3. All chemical containers are properly labeled.

   YES NO N/A

4. Chemicals are stored according to compatibility.

   YES NO N/A

5. Peroxide forming reagents are dated when opened.

   YES NO N/A

6. Peroxide forming reagents are disposed of or tested after exp. date.

   YES NO N/A

7. Flammable storage area(s) is labeled.

   YES NO N/A

8. Flammables are kept away from sources of heat, ignition, flames, etc.

   YES NO N/A

9. Corrosive chemical storage area(s) is labeled.

   YES NO N/A

10. Corrosive materials are stored low to the ground.

    YES NO N/A

11. Chemicals in the open are kept to a minimum.

    YES NO N/A

12. Flammable/Combustible liquids do not exceed NFPA storage limits.

YES NO N/A

13. Flammable/Combustible liquid total volume is not greater than 10 gal

YES NO N/A

14. Flammable gases are not present

YES NO N/A

15. Poisonous gases are not present

YES NO N/A

CHEMICAL WASTE

1. Hazardous waste containers are labeled and have closed lids.

YES NO N/A

2. Hazardous waste tags are complete.

YES NO N/A

3. Hazardous wastes are not stored beyond 90 days.

YES NO N/A

ADDITIONAL COMMENTS