
# CHEMICAL HYGIENE PLAN

September, 2022

# EMERGENCY INFORMATION

## EMERGENCIES

**Medical Emergency - Call 911**

Medical Care Centers*

| | | |
|---|---|---|
| FSU Birkam Health (M-F 8AM-5PM) | 1019 Campus Dr, Big Rapids | 231-591-2614 |
| Big Rapids Hospital – Spectrum Health - ER (Open 24 hours) | 605 Oak St, Big Rapids | 231-796-8691 |

*FSU Employees visit Birkam Health for on-the-job injuries except in cases of life or limb emergencies.

### Fire is discovered:

Activate Fire Alarm using red pull station
Initate Evacuation of building
If safe, Close Doors and Windows
Report Fires via 911

Only attempt to use a Fire Extinguisher if
You are trained in the use of extinguishers
It's safe to use and you have a clear exit

### Chemical Spill

For Incidental spills that do not pose a threat to health or safety:
Contact Instructor, Lab Supervisor or Safety Specialists.
For large spills that may pose a threat to health or safety:
Contact Public Safety or 911

### Severe Weather

Tornado Watch: Monitor weather conditions
Tornado Warning: Take Shelter in nearest shelter area

## CONTACTS

## DIAL 911 FOR ALL EMERGENCIES

**Non-Emergency:**
***FSU Campus Police*:** 231-591-5000
***FSU Facilities/Physical Plant***: 231-591-2920
***Big Rapids Public Safety***: 231-527-0005

**Department Contacts**
FSU Switchboard: 231-591-2000

**FSU Safety Contacts**

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|---|---|
| FSU Safety, Health, Environment and Risk Management | 231-591-2147<br>231-591-2151 |
| Radiation Safety | 231-591-2278 |

**Other Numbers**
**DTE Energy: Gas Leak:** 1-800-947-5000
**Consumers Power: Down Power Lines:** 1-800-477-5050
**Poison Control Center:** 1-800-222-1222

# Contents

# FSU STATEMENT OF COMMITMENT

Ferris State University (FSU) is committed to providing a safe work environment for the health and well-being of its faculty, staff and students. The following Chemical Hygiene Plan (CHP) supports that commitment. This CHP is prepared in accordance with State of Michigan Occupational Safety and Health Administration (MIOSHA) requirements (ie. MIOSHA Part 431).

Field work that is performed for FSU Laboratory courses or research efforts must comply with these rules; field appropriate safety plans and standard operating procedures must be developed for identified hazardous operations that occur in the field. FSU requires instructors to evaluate fieldwork hazards as a part of their specific lab plans.

The CHP contains FSU's policies for safe practices, emergency response actions, and reporting forms for use in any FSU laboratories or field studies. It does not contain a copy of the lab specific procedures and response actions that apply to a specific laboratory. Laboratory Specific Plans (SOP's) are found in their respective laboratories. The Laboratory Specific Plans need to be consistent with this CHP.

Faculty, staff, and students, working in laboratory areas must become familiar with the information covered in this document. In the event of a lab related emergency, response actions and reporting procedures are documented to assure compliance with regulatory requirements and FSU policies and procedures.

Although students are not included in the regulatory requirements of the MIOSHA Lab Safety Standard, FSU expects students who work in labs to become familiar with the basic information contained in this Plan. FSU has delegated the responsibility for providing students with a safe learning environment to the appropriate academic administrator, faculty and/or staff who supervise the students in the laboratories. Students are responsible for complying with these rules.

## 1.0 SCOPE

### 1.1 STATEMENT OF RESPONSIBILITY

FSU is committed to providing a work environment that is free from recognizable hazards for its faculty, staff, and students.

Faculty, staff and students are responsible to comply with this CHP.

### 1.2 CHEMICAL HYGIENE PLAN SCOPE AND APPLICATION

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

The CHP provides policies for handling hazardous materials in laboratories. The CHP establishes basic safety principles for laboratory procedures, equipment, and work practices capable of protecting employees from laboratory hazards.

Where the scope of hazards are not adequately addressed by this CHP, laboratory specific plans such as Standard Operating Procedures (SOPs) will be developed. Additionally, as programs expand and faculty and staff revise academic programs, this document will be updated accordingly.

This document will be referred to as the *Chemical Hygiene Plan* (CHP).

### 1.3 ROLES AND RESPONSIBILITIES

FSU Director of Safety, Health, Environment and Risk Management (SHERM): The FSU Director of SHERM is responsible for the development and implementation of institutional procedures for the establishment and maintenance of an environmental, health and safety program . The Director of SHERM serves as a resource for compliance with the CHP.

Chemical Hygiene Officer (CHO): As appointed by the Vice President of Administration and Finance, the CHO along with the academic unit college safety committees or designees, are responsible 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. The Chemical Hygiene Officer serves as a resource for compliance with the CHP. New projects, expanded use of hazardous chemical and biological materials, and/or physical hazards which pose unusual or uncontrollable risks shall be reviewed and approved by the CHO.

The Radiation Safety Officer (RSO) is responsible for compliance with state and federal requirements for using ionizing and non-ionizing radiation, including personnel monitoring. In each laboratory where ionizing and/or non-ionizing radiation is used, there will be an FSU employee who is responsible for certain essential functions to assure regulatory compliance and the safety of those using radiation. The Radiation Safety Officer is appointed by the Provost.

The Biosafety Officer (BSO): is responsible for compliance with state and federal requirements for using infectious agents or biologically hazardous materials.

Laser Safety: The CHO is responsible for approval of procurement and safe operation of class 3b and 4 lasers. Please contact the CHO for questions about laser use.

Campus Police will, with the assistance of Facilities Management and SHERM, coordinate response activities in the event of an emergency.

College Safety Committees comprised of faculty and staff appointed by the Dean assist the CHO in implementing the CHP.

University Employees are required to comply with the CHP.

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

Faculty will ensure that students and staff complete required chemical and lab safety training at the beginning of each course or research project in which hazardous materials are used. The training will be documented as appropriate (see section 2.0 below). Lab-specific safety training will be provided at the beginning of each class period on an as-needed basis.

Lab Supervisors have the responsibility for the safety and well-being of all persons in contact with radiation, chemical, laser, or biological hazards. Specifically, the lab supervisor is responsible for:

1. Ensuring that all employees under his/her supervision have received FSU laboratory safety training,
2. Providing all employees under his/her supervision with site-specific training and documenting such training,
3. Following procedures prescribed in this document, and in department or site-specific plans.
4. Coordinate the maintenance of lab and related equipment.

### 1.4 EMPLOYEE RIGHTS

It is the employee's right to receive information about the known physical and health hazards of the hazardous materials in their work areas and receives adequate training to work safely with these substances. Employees have the right to work in a safe environment and inform the laboratory supervisor about potential risks in the laboratory (per MIOSHA part 431 – Hazardous Work in Laboratories).

### 1.5 PLAN AVAILABILITY

The CHP is available at http://ferris.edu/SHERM

### 1.6 ANNUAL REVIEW

The CHO and Laboratory Safety Committee will review the CHP annually.

## 2.0 TRAINING

Employees will have access to information and training to ensure that they are informed of the hazards of materials present in their work area. Such information will be provided at the time of an employee's initial assignment to a work area where hazardous materials are present and prior to assignment involving new exposure situations. Employees will receive periodic refresher information and training to ensure that they are aware of the risks of exposure to hazardous materials.

### 2.1 GENERAL AWARENESS TRAINING

General awareness training will be provided by the CHO or other instructor and will include:

1. The content of MIOSHA’s Hazardous Work in Laboratories Standard and the location of the CHP.

2. A description of permissible exposure limits for certain MIOSHA regulated substances.

3. How to identify signs and symptoms associated with exposures to hazardous chemicals used in the laboratory (available on Safety Data Sheets).

4. Methods and observations that may be used to detect the presence or release of a hazardous material (such as monitoring conducted by continuous monitoring devices, visual appearance, or odor of hazardous chemicals when being released, etc.).

5. General physical and health hazards of chemical or biological material in the work area. This must include an awareness that many factors influence whether a given material might constitute a hazard (e.g., dose, exposure time, users' genetic background or developmental state, mixtures of interactions of chemicals, etc.).

6. The measures employees can take to protect themselves from these hazards, including specific procedures the University or department has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

7. The location and availability of known reference materials on the hazards, safe handling, storage, and disposal of hazardous materials found in the laboratory, including, but not limited to, Safety Data Sheets (SDS) received from the supplier. https://ferris.msdssoftware.com/

8. A description of the method of reporting signs and symptoms of exposure. (incident reporting)

## 2.2 LABORATORY-SPECIFIC TRAINING

Training on hazards specific to a task or area shall be provided to employees by lab supervisors or faculty and includes:

1. Site-specific emergency procedures
2. Site-specific standard operating procedures.
3. Specific physical and health hazards of materials in the work area (available on SDS).
4. Methods to prevent exposure of identified hazards and personal protective equipment.
5. Descriptive information on the function and use of general and local exhaust ventilation that serves the lab(s) in use.

## 2.3 METHOD OF TRAINING

Training may take the form of individual instruction, group seminars, audiovisual presentations, handout material, computer-based learning management programs, or any combination of the above.

## 2.4 RECORD KEEPING

A record of general awareness training will be maintained by the CHO. A record of lab specific training will be maintained by the lab supervisor.

Employee training records are maintained for length of employment plus one year. Student training records are maintained for one year after the completion of the course.

## 3.0 STANDARD OPERATING PROCEDURES

The CHP provides health and safety procedures that apply to laboratory work involving the use of hazardous chemicals, hazardous biological materials, and/or operations with a high degree of risk. Standard Operating Procedures (SOPs) are prepared when additional safety measures are necessary for labs with health and safety hazards greater than those addressed in the CHP .

### 3.1 CREATING STANDARD OPERATING PROCEDURES

Principal Investigators and lab supervisors must assess the risks and hazards associated with the lab. If the risks can not be controlled by the procedures within the CHP then SOPs are necessary to address these hazards. SOPs are developed by the Principal Investigator or Lab Supervisor.

### 3.2 GENERAL SAFETY PRINCIPLES

The following guidelines have been established to assist lab faculty and staff in managing potential hazards and in maintaining a basic level of safety. Below are guidelines that establish minimum requirements for those who may use and/or work in labs.

1. Understand the hazards associated with the materials being used. Never assume all hazards have been identified. Carefully read labels before using an unfamiliar chemical. When appropriate, review the Safety Data Sheet (SDS) for special handling information. Determine the potential hazards and use appropriate safety precautions before beginning any new operation.

2. Be familiar with the location of emergency equipment such as fire alarms, fire extinguishers, emergency eyewash, and shower stations, and know the appropriate emergency response procedures.

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 and call attention to them so that corrective action can be taken as quickly as possible.

6. Wear appropriate skin, eye, and face protection.

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

8. Do not taste or smell chemicals.

### 3.3 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.

2. Confine long hair and loose clothing.

3. Always wear footwear that fully covers the feet. No open toe shoes allowed.

4. Do not mouth-pipette.

5. Conduct work in a lab hood when there is a potential for exposure to hazardous gases, vapors, or aerosols. Check to ensure that exhaust ventilation equipment is working properly. In the event that general or local exhaust ventilation (lab hood) is not functioning properly, stop work and notify Facilities. Place a sign to notify others that work with hazardous materials is suspended until the equipment is working properly.

6. Before eating, drinking, smoking or applying consmetics thoroughly wash hands with soap and water.

7. Wear goggles when there is a risk of a splash to the eyes.

8. Assign personal protective equipment to individuals and provide a clean location to store when not in use.
9. Understand the signs and symptoms of exposure.

10. Understand the precautions necessary to prevent exposure to chemicals.

### 3.4 FOOD AND DRINK IN THE LABORATORY

1. No eating, drinking, smoking, or applying of cosmetic products in any laboratory areas .

2. Refrigerators and microwave ovens used for chemical or biological storage or other laboratory use shall not be used for food storage or preparation. Refrigerators and microwaves for lab use will be labeled with “Do not use for human consumption”

3. Food or beverages for research or experimental purposes should be labelled as such or with the words “not for human consumption”.

### 3.5 HOUSEKEEPING

The following minimum guidelines are used to maintain an orderly laboratory:

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

2. Dispose of clean broken glass in a Broken Glass Disposal Box.

3. Clean up incidental spills immediately

4. Do not block exits, emergency equipment or controls. Do not use hallways and stairwells for storage.

5. Ensure hazardous chemicals are properly segregated into compatible categories.

### 3.6 HAZARDOUS MATERIALS HANDLING AND STORAGE

Safety Data Sheets (SDS) are located in labs or at https://ferris.msdssoftware.com/. SDS’s contain information on proper handling and storage of hazardous materials.

1. Do not accept shipments of chemical with missing or defaced labels.

2. Chemicals utilized in the laboratory or hood must be appropriate for the type and capacity of the ventilation system.

3. Biological materials will be manipulated using safety equipment and techniques appropriate to the evaluated biosafety level. Biosafety cabinets must be functioning properly and certified annually.

4. Hazardous materials will be stored in appropriate safety cabinets.

5. Segregate stored chemicals by compatibility.

6. Do not store chemicals alphabetically.

7. Hazardous material storage areas must be labeled with an appropriate warning sign.

8. Mimimize storage of hazardous materials in the lab.

9. A Hazardous material mixture shall be assumed to be as toxic as its most toxic component.

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

11. Each lab must maintain an inventory of chemicals. These inventories are submitted to SHERM office annually. The SHERM office maintains the online SDS database at: https://ferris.msdssoftware.com/.

### 3.7 TRANSFERRING OF HAZARDOUS MATERIALS

When transporting hazardous materials outside the laboratory, precautions will be taken to avoid dropping or spilling.

1. Use containers that are compatible with the contents.
2. Containers must be in good condition, with no leaks and with no chemical residue on them.
3. Containers must be closed with the lids securely in place.
4. Do not overfill containers, leaving headspace for expansion.
5. Containers must be transported on a cart, in a secondary container such as a tray or bottle carrier to prevent spills.
6. Wear appropriate PPE.
7. Containers must be labeled.
8. Use a Sharpie or a ballpoint pen to fill out the labels.
9. Labels must be filled out completely and be written legibly.
10. Provide as much detail as possible in the space provided on the label.
11. Attach additional supplemental information if necessary. (ie: SDS, package insert)
12. If the label is too large to be affixed to the container, place each container into a separate clear, secondary container bin and place a completed label in the bin.
13. Limit transportation of containers to times of low hallway traffic.
14. Do not transport hazardous waste between buildings.

### 3.8 COMPRESSED GASES

Special systems are needed for handling materials under pressure. Cylinders pose mechanical, physical and/or health hazards, depending on the compressed gas in the cylinder.

1. Cylinders with regulators must be individually secured. Only cylinders with valve protection caps securely in place may be safely gang-chained (chained in groups).

2. When storing or moving a cylinder, have the valve protection cap securely in place to protect the stem.

3. Cylinders must be secured in an upright position at all times. Use suitable racks, straps, chains, or stands to support cylinders against an immovable object, such as a bench or a wall, during use and storage. Do not allow cylinders to fall or lean against one another.

4. Use an appropriate cart to move cylinders.

5. Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.

6. Oil or grease on the high-pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder. Use an oxygen approved regulator.

7. Always wear goggles or safety glasses with side shields when handling compressed gases.

8. Use appropriate gauges, fittings, and materials compatible with the particular gas being handled.

9. When work with a toxic, corrosive, or reactive gas is planned, the CHO should be contacted for information concerning specific handling requirements. Generally, 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.

10. Outside contractors/suppliers have been hired to exchange empty cylinders with full ones. Faculty and staff should limit moving cylinders, but when necessary, use the cylinder restraint cart.

### 3.9 UNATTENDED OPERATIONS

Unattend operations are not recommended. At times, it may be necessary to leave a laboratory operations unattended. Follow these basic guidelines in the design of an experiment or project to be left unattended:

1. Check with your laboratory supervisor to determine if the operation can be left safely unattended.

2. If the operation is to be left unattended for extended periods and involves hazardous materials or potentially hazardous conditions, develop a protocol. It should be reviewed by the laboratory supervisor and CHO. The protocol should include responses to potential interruptions in electric, water, inert gas and other services and provide containment for hazardous materials.

3. 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.

### 3.10 WORKING ALONE

Working alone, whether after-hours or in isolation, should be avoided whenever possible. If it becomes necessary to conduct work alone in a laboratory, workshop, or in the field, the Principal Investigator or Lab Supervisor must specify the conditions under which working alone will be permitted. The Dean must authorize working alone.

1. In no case is working alone permitted during procedures involving highly hazardous or toxic chemicals or agents and/or dangerous equipment or environments (i.e.: anything that could cause severe injury or death).

2. It is the responsibility of the Principal Investigator or Lab Supervisor, with support of CHO to develop lab specific safety plans that address the hazards associated with working alone. This includes access to emergency assistance and notification of ongoing work.

### 3.11 VOLUNTEERS AND GUEST SCHOLARS IN LABS

Individuals wishing to conduct research for the benefit of the university, but with no compensation, will fall into one of the following categories:

1. Laboratory Volunteers must be working under the direction of a Principal Investigator or Laboratory Supervisor. Volunteers must be approved by the Dean.
2. Guest Scholars associated with other universities, must be approved by the College Dean to participate in lab work.

3. Volunteers and guest scholars are subject to the provisions of this Plan and the following requirements:

    (a) Any volunteer or guest conducting lab work must sign an agreement and release form prior to working in a lab. The agreement includes at a minimum the following:

b) Acknowledgment of understanding of the CHP.
c) A clearly defined scope of work and disclosure of significant hazards.
d) Acknowledgment of safety training prior to working in the lab.

2) Guest Scholars must have a signed approval letter from the Dean, Laboratory Use Agreement, a background check, completed volunteer consent (See Appendix L), and possibly other documentation as required by the Office of Research and Sponsored Programs Compliance Officer. Contact the CHO for more information.

### 3.12 LABORATORY SECURITY

Laboratories must be secured using reasonable measures to prevent against theft, unauthorized entry, and misuse of chemicals or equipment, especially those that could present a risk to the public or be used for illicit purposes.

1. Laboratory Personnel Responsibilities: For research labs, Principal Investigators are responsible for the security of their laboratories. In teaching labs, the Department Chair is responsible for chemical and equipment security. All laboratory staff and students should take the following precautions:

    a. Be aware of unfamiliar individuals in restricted areas. Either approach them to inquire as to their purpose in the area (“can I help you? “) or report to faculty or staff.
    b. Report suspicious behavior and security problems to Public Safety.
    c. Ensure doors from public access areas into restricted access areas remain locked. Do not prop doors open.
    d. Do not provide access to unfamiliar individuals.
    e. Keep accurate inventories of chemicals and equipment.
    f. Do not leave hazardous materials or valuable equipment unsecured.
    g. Properly dispose of unwanted chemicals.

2. Laboratory Access: Faculty, staff and students will be provided with access upon approval by the Department Chair or Dean of the College, or their designee. Keycard or keycode restrictions are as follows:

    a. Academic departments and/or the Dean of the College will determine individuals who are authorized to request issuance of a keycard. The individual making request shall maintain a record of all cards and names that they have been assigned to. In the event of a lost/stolen keycard, the authorized individual shall have the card cancelled immediately.
    b. Faculty and staff cards/codes will be deactivated upon request of the Department Chair or termination of employment. Student cards will be issued for a term not longer than one year, at which time the authorized individual must request an extension.
    c. PI's may request any access times for student cards during typical building operating hours without prior approval. Additional access will be granted upon demonstration of established policies for after-hours access. PI's requesting after-hours access for their research staff must provide the Department Chair or Dean with:
        i. Identification of the room/space where access is being requested.
        ii. A description of lab work and potential hazards, if any.
        iii. Specific policies for working alone in the space.
    d. Access to certain restricted areas will only be granted upon approval by the Department Chair. Each individual entering such areas must swipe his or her card on the reader, unless access is part of a class or the individual is directly supervised by the Principal Investigator.
    e. Do not allow unknown individuals into key-carded areas. Cardholders are responsible for the actions of any individuals that they allow into a secure area.

## 4.0 CHEMICAL HANDLING & STORAGE REQUIREMENTS

### 4.1 HAZARD IDENTIFICATION

Containers must be labeled with the chemical name(s) and associated hazard(s).

1. Do not remove or deface manufacturer label(s). It is recommended that incoming containers be labeled with the department or user name and date received.

2. Laboratory containers must be labeled.

3. Hazardous material storage areas must be labeled.

4. Entranceways to laboratory facilities must be labeled with the appropriate warning signs.

5. All employees must have access to Safety Data Sheets.

### 4.2 LABELING

All containers must be labeled

1. Verify labels include the proper information:

    a. For containers labeled by the manufacturer:
        i. Inspect the labeling on incoming containers.
        ii. Replace damaged or semi-attached labels.
    b. For transferred products or prepared solutions labeled by the user:
        i. Label each chemical container with the chemical name and hazard warning
        ii. Refer to the SDS for hazard warning
    c. For Labeling Multiple Small Containers using Legend Method.
        i. Label containers with abbreviated chemical name and a hazard warning.
        ii. Provide a key in a visible location in the lab with complete chemical name.
        iii. Document that employees are trained on the labeling system.
    d. For labeling multiple small containers using the box or tray method:
        i. Put containers in box or tray.
        ii. Label tray with chemical name and hazard warning
        iii. If containers are removed from the box/tray, they must be properly labeled or returned to the box or tray within the work-shift.
    e. Peroxide Forming Chemicals must be labeled with: Date received, opened, tested, and results.

2. Labels must contain the appropriate hazard warnings.

    a. Labels must be clearly legible and prominently displayed on the container.
    b. Carcinogens must be labeled as a CARCINOGEN or MAY CAUSE CANCER.
    c. Stationary process containers or any process that might create a health hazard during the normal completion of a given task (welding, for instance) the label can be replaced by a sign, placard or batch ticket indicating the identity and nature of the hazard.
    d. Any portable vessel containing chemicals must be labeled.
    e. Employees must not remove or deface any label without express consent from a supervisor or appointed Chemical Hygiene Officer. Any container without a label should be reported by the employee to his/her supervisor.
    f. The identity on the container label must read exactly as it does on the Safety Data Sheet.
    g. Products in “ready to use” containers are labeled by the manufacturer.

## 4.3 CHEMICALS DEVELOPED IN THE LABORATORY

The following requirements apply to chemical substances produced in the laboratory:

1. If the composition of the chemical substance that is produced exclusively for the laboratory's use is known, the lab supervisor must create a lab specific SOP. If the chemical is determined to be hazardous, the lab supervisor must provide appropriate training to protect employees and provide a written procedure for handling, use, and disposal of the chemical compound.

2. If the chemical produced is a product or a by-product that has an unknown composition, the lab supervisor must assume that the substance is hazardous and must comply with the requirements of the CHP.

3. If the chemical is produced for use outside of the laboratory, the lab supervisor must prepare an appropriate SDS in accordance with Michigan's Right-to-Know Law.

## 4.4 HAZARDS SUBJECT TO REVIEW OR PRIOR APPROVAL

1. All academic and research activity with potential exposure to hazardous chemicals, biological agents, equipment, or work areas is subject to review by the CHO. The MIOSHA standards will be used as a minimum for this review.

2. If the lab has high risk operations that cannot be eliminated or controlled, the Dean, CHO, and Lab Safety Committee must provide approval prior to the activity taking place.

3. Additional hazard assessments will be conducted by the responsible faculty member annually for procedures that have expanded in scope or increased potential hazards.

## 4.5 PROVISIONS FOR PARTICULARLY HAZARDOUS SUBSTANCES

1. Permissible Exposure Limits (PEL) and Threshold Limit Values (TLV)

   The CHP uses PEL's and TLV's to evaluate and minimize exposure to chemiclas. MIOSHA publishes and enforces PEL's and the ACGIH publishes the TLV's as guidance.

2. Employee Monitoring

   The CHO will perform employee exposure monitoring under the following circumstances:

   a. Initial monitoring must be performed if there is reason to believe employee exposure levels routinely exceed the action level, or PEL.

   b. Periodic monitoring must be performed when initial monitoring reveals an exposure. The employer must comply with exposure monitoring provisions of the relevant standard.

   c. Employers must notify the employee of the monitoring results within 15 working days after receipt of monitoring results. Records of exposure monitoring data will be retained by SHERM.

3. Special Considerations.

Special precautions for additional employee protection will be followed for the laboratory use of select carcinogens, reproductive toxicants, and chemicals with a high degree of acute and chronic toxicity. The following general hygiene standards will be observed.

1. Establish a designated area.

    a. Use and store materials only in designated areas such as a restricted access hood, glove box, or portion of a lab designated for use of highly toxic substances. Assure that all personnel with access are aware of necessary safety precautions and engineering controls are adequate.
    b. Label all containers, storage and use areas appropriately.

2. Use proper containment devices for the protocol and chemical(s) being used.

    a. Use a hood or other containment device for procedures which may result in the generation of aerosols or vapors.
    b. It is recommended that breakable containers be stored in chemical-resistant trays. Work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper.

3. Prior to removing contaminated waste, contact SHERM for waste disposal guidelines.

4. Follow decontamination procedures prior to leaving the designated area.

    a. Before leaving the designated area, remove protective apparel. Place it in an appropriate, labeled container for disposal. Thoroughly wash hands, forearms, face, and neck.
    b. Decontaminate vacuum pumps or other contaminated equipment, including glassware, before removing them from the designated area. Decontaminate the designated area before normal work is resumed.
    c. Use a wet mop or a vacuum cleaner equipped with a HEPA filter to decontaminate surfaces contaminated with particulates. DO NOT DRY SWEEP.
    d. Protect vacuum pumps against contamination.

5. Always take extra precautions when working with particularly hazardous substances.

    a. Consult the SDS for toxic properties and follow the specific precautions and procedures.
    b. Guard against spills and splashes. Appropriate safety apparel, especially gloves, should be worn. All hoods, glove boxes, or other essential engineering controls should be operating properly before work is started.
    c. Notify the Lab Supervisor immediately of all incidents of exposure or spills.

## 4.6 PROVISIONS FOR PHYSICAL HAZARDS OF CHEMICALS

Physical hazards of chemicals are provided below. User must take certain precautions to avoid personal injury or property damage. Additionally, users should understand chemical incompatibilities and avoid storage or mixing practices that may cause a violent reaction or a toxic gas.

### 4.6.1 Flammable/Combustible Material

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

| Flammable | Flash Point* | Boiling Point |
|---|---|---|
| Class IA | < 73°F (22.8°C) | < 100°F (37.8°C) |
| Class IB | < 73°F (22.8°C) | ≥100°F (37.8°C) |

| | | |
|---|---|---|
| Class IC | ≥73°F (22.8°C) <100°F (37.8°C) | |
| **Combustible** | **Flash Point*** | |
| Class II | ≥100°F (37.8°C)&< 140°F (60°C) | |
| Class IIA | ≥140°F (60°C)&< 200°F (93°C) | |
| Class IIIB | ≥200°F (93°C) | |

*Flash Point is defined as the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

For handling flammable/combustible materials, observe the following guidelines:

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

2. Store in NFPA approved flammable liquid containers or storage cabinets, in an area isolated from ignition sources or in a special storage room designed for flammable materials.

3. Ensure there is proper bonding and grounding when it is required, such as when transferringor dispensing a flammable liquid from a container or drum. Ensure bonding andgrounding is checked periodically.

4. Ensure appropriate fire extinguishers and/or sprinkler systems are in the area.

5. No storage of flammable chemicals in container sizes greater than 1 gallon (4 L) will be permitted in labs unless:
   a. The flammable chemicals are stored in a flammable storage cabinet
   b. The flammable chemicals are stored in an approved flammable safety can.

6. Maximum quantity of flammable chemicals in a lab should not exceed 5 gallons (20 L) of flammable chemicals, outside flammable storage cabinets.
7. See Appendix C

### 4.6.2 Corrosives

Corrosives are materials which can react with the skin causing burns similar to thermal burns, and/or which can react with metal causing deterioration of the metal surface.

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

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

3. Never add water to acid. When mixing concentrated acids with water, add the acid slowly to water.

4. An eyewash and safety shower must be readily accessible to areas where corrosives are used and stored. In the event of skin or eye contact with corrosives, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Obtain medical help.

5. See Appendix D

### 4.6.3 Oxidizers

Oxidizers are materials that react with other substances by giving off electrons and undergoing reduction. This reaction may result in fire or explosion. The intensity of the reaction depends on the oxidizing-reducing potential of the materials involved. Know the reactivity of the materials involved in the experiment or process. Ensure there are no extraneous materials in the area that could become involved in a reaction. If the reaction is anticipated to be violent or explosive, use shields or other methods for isolating the materials or the process. See Appendix E

### 4.6.4 Water Reactive Materials

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

### 4.6.5 Pyrophoric Materials

Pyrophoric Materials are materials that ignite spontaneously upon contact with air. Often the flame is invisible. Examples of pyrophoric materials are silane, silicon tetrachloride, and white or yellow phosphorous. Pyrophoric chemicals should be used and stored in inert environments, and dated when received and opened.

### 4.6.6 Peroxidizable Chemicals

Peroxidizable Chemicals (Organic Peroxides) are materials which undergo auto-oxidation (a reaction with oxygen in the air) to form peroxides which can explode with impact, heat, or friction. Since these chemicals may be packaged in an air atmosphere, peroxides can form even though the container has not been opened, necessitating careful handling. Date all peroxidizables upon receipt and upon opening. Dispose of or check for peroxide formation after the recommended time depending on the chemical. See Appendix F – Common Peroxide Forming Chemicals and Protocol for Detection and Inhibition of Peroxides. Do not open any container that is deformed or has obvious solid formation around the lid.

### 4.6.7 Light Sensitive Materials

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

### 4.6.8 Unstable Materials

Unstable Materials are compounds that can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some chemicals become increasingly shock-sensitive with age. Of great concern in the laboratory is the inadvertent formation of explosive or shock-sensitive materials such as peroxides, perchlorates (from perchloric acid), picric acid, and azides.

1. Contact the CHO when it is suspected that the inadvertent formation of shock-sensitive materials in ductwork, piping, or chemicals being stored has occurred.

2. Date all containers of explosive or shock-sensitive materials upon receipt and when opened.

3. Store containers of shock sensitive or explosive materials in unbreakable secondary containers, away from heat and direct sunlight.

4. If there is a chance of explosion, use barriers or other isolation methods.

5. See Appendix G

### 4.6.9 Cryogens

Cryogens are liquefied gases that can condense oxygen from the air to create an oxygen rich atmosphere in the nitrogen solution; increasing the potential for fire if flammable or combustible materials are present. Asphyxiation and container over-pressurization are significant hazards due to the large expansion ratio from liquid to gas (700 to 1). Many materials become brittle at extremely low temperatures. Brief contact with materials at extremely low temperatures can cause burns similar to thermal burns. Some of the hazards associated with cryogens are fire, pressure, weakening of materials, and skin or eye burns upon contact with the liquid.

1. Equipment should be kept clean, especially when working with liquid or gaseous oxygen.

2. Gases or fluids should be controlled to prevent formation of flammable or explosive mixtures.

3. Always wear safety glasses with side shields or goggles when handling. If there is a chance of a splash or spray, a full-face protection shield, an impervious apron or coat, cuffless trousers, and high-topped shoes should be worn. Watches, rings, and other jewelry should not be worn. Gloves should be impervious and sufficiently large to be readily thrown off should a cryogen spill. Potholders could also be used.

4. Containers and systems containing cryogens should have pressure relief mechanisms.

5. Containers and systems should be capable of withstanding extreme cold without becoming brittle.

6. Since glass ampoules can explode when removed from cryogenic storage if not sealed properly, storage of radioactive, toxic, or infectious agents should be placed in plastic cryogenic storage ampoules. Reheat cold sample containers slowly.

### 4.6.10 Carcinogens

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

1. It is regulated by OSHA as a carcinogen; or
2. It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
3. It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer
4. Monographs (IARC) (latest editions); or
5. It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
    a. After inhalation exposure of 67 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;

b. After repeated skin application of less than 300 (mg/kg of body weight) per week; or
c. After oral dosages of less than 50 mg/kg of body weight per day.

## 4.7 IONIZING AND NON-IONIZING RADIATION AND RADIOACTIVE MATERIAL

The use of radioactive materials and equipment that produces ionizing and non-ionizing radiation at FSU is strictly controlled by the Radiation Safety Officer (RSO). Faculty and staff working in departments that involve the use of radioactive materials are required to follow the safety practices documented in FSU's Radiation Safety Manual and any lab specific SOP's. If there are any questions regarding the information or requirements of working in the area, contact FSU's RSO.

## 4.8 BIOLOGICAL MATERIAL HAZARDS

The current definition of Biological Risk Groups and Biosafety Levels (BSL) are found in the CDC / NIH Guideline, "Biosafety in Microbiological and Biomedical Laboratories". BSL 1 work can be conducted within appropriate labs following the standard microbiological practices as described in the Guidelines. BSL 2 work requires addional protective measures following the standard microbiological practices as described in the Guidelines. BSL 2 work is approved by the Dean and SHERM. BSL 3 & 4 work is prohibited unless conducted in a purpose built facility with approval from the Dean and SHERM. Contact SHERM if you plan to use biological materials at or above Biosafety Level 2 or potentially infectious agents. See the Institutional Biosafety Committee for additional information - https://www.ferris.edu/administration/academicaffairs/vpoffice/Academic_Research/IBC.htm

## 5.0 LABORATORY FACILITY REQUIREMENTS

### 5.1 IDENTIFICATION OF HAZARDS

Labels and warning signs should alert employees to potentially hazardous materials and allow those unfamiliar with the laboratory surroundings to identify hazardous chemical use and storage areas, safety facilities, emergency equipment, exits, and aid emergency response personnel.

#### 5.1.1 Safety Data Sheets (SDSs).

A Safety Data Sheet (SDS) is a document containing chemical hazard identification and safe handling information and is prepared in accordance with the MiOSHA Hazard Communication Standard and the Michigan Right-to-Know law. Chemical manufacturers and distributors must provide the purchasers of hazardous chemicals an appropriate SDS for each hazardous chemical/product purchased.

The SDS database, based on lab inventories, can be found at https://ferris.msdssoftware.com/.

#### 5.1.2 Generic Signs

Lab door signage includes the following items:

1. Emergency contact numbers.
2. Laboratory hazard information

#### 5.1.3 Restricted Access and Designated Areas.

Facilities containing certain hazards must have warning signs posted at the designated area of the laboratory where the hazard exists, and at the entranceway to the laboratory. Any areas placarded as such are restricted access, designated areas, and have certain standards regarding training and use by employees. Such hazards include:

1. MIOSHA carcinogens (see Appendix P or contact CHO if you have questions)
2. HIV and HBV research laboratories and production facilities
3. Biological agents that require Biosafety Level 2 or higher controls
4. Sources of ionizing radiation
5. Radioisotopes and radiolabeled materials
6. Areas with high magnetic fields, UV light, laser usage, or radio frequency generators

Other hazards will be addressed on a case-by-case basis with consultation from the CHO.

#### 5.1.4 Storage Areas.

Chemicals should be stored according to compatibility as designated by hazard classes. Review the SDS for proper storage guidelines. Assure that the following areas are labeled and chemicals are stored appropriately:

1. Carcinogens
2. Corrosives
3. Flammable Liquids
4. Flammable Solids
5. Oxidizers
6. Perchloric Acid
7. Biosafety Level 2 or higher

### 5.2 CONTROL MEASURES

Control measures must be evaluated when the following circumstances are met:

1. Whenever employees use hazardous materials.
2. Whenever employee exposures exceed the action level (or, in the absence of an action level, the Permissible Exposure Limit, the published exposure limit or the Threshold Limit Value).
3. Upon addition of new chemicals or changes in procedures.
4. Other situations will be addressed on a case-by-case basis. Please consult the CHO for assistance in establishing the appropriate control measure.

Use the following primary methods for detecting exposures:

1. Determine the source of exposure.
2. Determine the path the contaminant follows to reach the faculty, staff and students.
3. Determine the work pattern and use of personal protective equipment.

#### 5.2.1 Administrative Controls

Methods of controlling employee exposures to contaminants by job rotation, work assignment or time periods away from contaminant. Examples include Standard Operating Procedures, Chemical Hygiene Plan, and Safety Manuals.

1. Substitute less harmful chemicals whenever possible.
2. Change or alter processes to minimize exposure.
3. Provide training and education.

#### 5.2.2 Engineering Controls

Methods of controlling employee exposures by modifying the source or reducing the quantity of contaminants released into the work environment. Examples include fume hoods, biosafety cabinets and chemical containment.

1. Isolate or enclose a process or work operation to reduce the exposure (i.e. fume hood, glove box, etc.).
2. Use local exhaust ventilation (hoods) at the point of generation or dispersion of contaminants.
3. Use wet methods to reduce the generation of dust.
4. Use special control methods such as shielding and continuous monitoring devices to control exposures in special situations.
5. Practice good housekeeping procedures to reduce unnecessary exposures.
6. Vent storage cabinets where possible.
7. Additional engineering controls may be determined by the CHO

## 5.3 PERSONAL PROTECTIVE EQUIPMENT

FSU will provide necessary engineering controls and safety equipment to maintain a safe working environment. It is the lab supervisor or PI's responsibility to ensure proper use and care of such equipment.

The lab supervisor or PI is responsible for hazard evaluation, PPE determination, and enforcement of required PPE rules in their lab. In common or prep areas, laboratory technitions are responsible for ensuring that PPE requirements are followed. The SDS will provide information on the PPE and safety procedures recommended for a given chemical.

#### 5.3.1 Eye and Face Protection

Eye protection is available to faculty, staff, students and visitors to laboratories where chemicals are used and stored. Protective eye and face equipment must be used where there is a reasonable probability of injury from hazardous materials.

Specialized types of eye protection, such as ultraviolet light restricting safety glasses, are available on an as needed basis. All eye protective devices for laboratory use must be stamped with "Z87" by the manufacturer.

1. Safety glasses with side shields offer protection against flying fragments, chips, particles, sand, and dirt. Safety Glasses are the minimum level of eye protection required when an impact hazard exists or when working with hazardous materials.

2. Safety goggles (impact goggles) offer adequate protection against flying particles. These should be worn when working with glassware under reduced or elevated pressure or with drill presses, grinders or other similar conditions.

3. Chemical splash goggles have indirect venting for splash proof sides, which provide adequate protection against splashes. Chemical splash goggles offer the best eye protection from chemical splashes. Impact goggles should not be worn when danger of a splash exists. Chemical Splash Goggles are required when working with corrosive or injurious chemicals and a reasonable probability of splash exists.

4. Face shields protect the face and neck from flying particles and splashes. Always wear additional eye protection under face shields. Ultra-violet lightface shields should be worn when working over UV light sources. Face Shield and Chemical Splash Goggles are required when working with larger quantities of corrosive chemicals or a high probability of eye and face injury exists.

Note: Ordinary prescription glasses do not provide adequate protection against eye injury. Eye protection equipment must be ANSI Z87 approved.

### 5.3.2 Protection of Skin and Body

Skin and body protection involves the use of protective clothing to protect individuals from exposure. Determine clothing needed based on the hazard assessment.

1. Protect exposed skin surfaces when there is a reasonable anticipation of a splash or exposure.
2. Open toed shoes and sandals are not permitted in labs.
3. Even when there is minimal danger of skin contact with an extremely hazardous substance, lab coats, coveralls, aprons, or protective suits should be utilized. These garments should not leave the lab.
4. Exposures to strong acids and acid gases, organic chemicals and strong oxidizing agents, carcinogens, and mutagens require the use of specialized protective equipment that prevents skin contamination. Impervious protective equipment must be utilized.

### 5.3.3 Hearing Protection

Hearing protection is required where noise levels exceed MIOSHA limits. Contact the CHO for evaluation of high nose areas or operations.

### 5.3.4 Respiratory Protection

Generally laboratories are provided with fume hoods to prevent situations where respirators would be necessary. See appendix for FSU's Respiratory Protection Policy.

## 5.4 SAFETY EQUIPMENT

### 5.4.1 Safety Showers

Safety Showers are required to provide an immediate water drench of an affected person. MIOSHA has adopted the following ANSI standards for location, design, and maintenance of safety showers:

1. Showers are located within 25 feet of areas where chemicals with a pH of < 2.0 or > 12.5 are used.
2. Showers are located within 100 feet of areas where chemicals with a pH between 2 and 4 or 9 and 12.5 are used.
3. Shower location is to be clearly marked, well lighted, and free of obstacles, closed doors, or turns.
4. Safety showers are checked and flushed monthly by the Lab Supervisor, Principle Investigator or designee. A log documenting flushes is recommended.

### 5.4.2 Eyewash Facilities

Eyewash Facilities are required in all laboratories where injurious or corrosive chemicals are used or stored and are subject to the same proximity requirements as safety showers. MIOSHA has adopted the following ANSI standards for location, design, and maintenance of emergency eyewash facilities:

1. Optimally, those affected must have both hands free to hold open the eye to ensure an effective wash behind the eyelids. This means providing eyewash facilities that are operated by a quick release system and simultaneously drench both eyes.

2. Eyewash facilities at FSU will provide the minimum of a 15-minute water supply at no less than 0.4 gallons per minute.

3. Eyewash facilities should be checked and flushed weekly by the Lab Supervisor, Principle Investigator or designee. A log documenting flushes is recommended.

### 5.4.3 First Aid Kits

First aid kits should be readily accessible to all laboratory personnel and should be inspected frequently to ensure that the kit is sufficiently stocked. The kit need only to provide equipment for minor cuts and scrapes. First aid kits can be purchased and restocked by the Birkam Helath Center.

### 5.4.4 Spill Kits

Ready access to a spill kit is required in laboratories that work with hazardous materials. Faculty and staff should be trained on spill procedures. Contact the CHO or lab supervisor for assistance in selecting appropriate spill supplies.

### 5.4.5 Fire Extinguisher

Fire extinguishers are placed in labs as required based on the materials used in the lab. The fire extinguisher in the laboratory should be the appropriate classification type for the expected fire. Type A are used on combustible (wood, paper rubber, plastic) fires, Type B are used on flammable liquid fires, Type C are used on energized electrical equipment fires, and Type D are used on combustible metal (lithium, sodium, magnesium, potassium) fires. Multipurpose (Type ABC and Type BC) extinguishers are also available. SHERM inspects fire extinguishers annually. Custodians conduct monthly inspections. If an extinguisher requires a recharge, submit a work order to Facilities Management for an exchange.

### 5.4.6 Telephone and Emergency Contact List

Each laboratory must have access to a telephone and emergency contact phone numbers.

## 5.5 LABORATORY VENTILATION

Lab ventilation controls are those controls intended to minimize employee exposure to hazardous chemicals by removing air contaminants from the work site. There are two main types of ventilation controls:

1. General (Dilution) Exhaust: a room or building-wide system that brings in air from outside and ventilates within. Laboratory air must be continually replaced, preventing the increase of air concentration of toxic substances during the workday. General exhaust systems are not recommended for the use of most hazardous chemicals.

2. Local Exhaust: a ventilated, enclosed workspace intended to capture, contain, and exhaust harmful or dangerous fumes, vapors, and particulate matter generated by procedures conducted with hazardous chemicals. These may include fume hoods and biological safety cabinets.

For use of hazardous chemicals warranting local ventilation controls, the following guidelines should be observed:

### 5.5.1 Fume Hood Safe Work Practices

1. Conduct all operations that may generate air contaminants in a hood.
2. Do not put your head or upper body into the hood.
3. Hoods should not be used for permanent storage of hazardous materials or equipment. With the exception of certain hazardous waste containers, all chemicals should be stored in an appropriate location outside of the hood.
4. Hazardous materials and equipment should be placed at least six inches inside the hood for proper containment of chemical vapors. Place heat generating equipment to the rear of the hood.
5. Equipment inside the hood should be placed so as to not block airflow through slots in the baffle. Blocks may be necessary under large equipment to allow air to flow to the rear baffle.
6. The fume hood safety-glass sash should be kept below the “stopper” at approximately 18”. In general, the sash height should be set at a level where the operator is shielded from any explosions or violent reactions which could occur and where optimum airflow dynamics are achieved. If a fume hood has no markings regarding sash height or inspection dates, please contact the CHO to arrange for an inspection.
7. Alarms: Most hoods are equipped with flow sensors. They will generally alarm if flow is too low or too high. Adjust the sash height to correct alarm conditions. If an alarm continues, stop using the hood and contact a Lab Supervisor or Facilities Management. The alarm can be “muted”, however the hood should not be used until the proper flow rate is shown on the monitor.
8. Emergency Purge: In the event of a spill, smoke, or other unintended vapors, press the emergency button on the hood to increase to maximum fan speed.
9. When not in use the hood should be completely closed to reduce energy consumption.
10. Minimize foot traffic and other forms of potential air disturbances past the face of the hood.
11. Do not have sources of ignition inside the hood when flammable liquids or gases are present.
12. Annual hood inspections are conducted to maintain proper air flow and certify the hood for operation.
13. Never work with hazardous chemicals or biohazards if the ventilation system is not working.

14. Hoods should not be used as a waste disposal mechanism for volatile materials.
15. Do not block air supply vents or exhausts in the room.
16. Perchloric Acid Hoods: Use of perchloric acid must be done in a designated hood. Currently perchloric acid use is discouraged at FSU and no hoods have been designated.
17. Always use proper personal protective equipment when working with chemicals in a hood.

### 5.5.2 Biological Safety Cabinet Safe Work Practices

The Biological Safety Cabinets (BSC) are used to provide containment of infectious splashes or aerosols generated by many microbiological procedures. BSC's are used when working with infectious agents. BSC's use High Efficiency Particulate Air (HEPA) filters to protect personnel and products inside the BSC from contamination from aerosols and particulates. They also protect the laboratory by isolating and containing the work in progress within the BSC.

Guidance for safe use of biological safety cabinets:

1. Never use chemicals with the potential to generate hazardous vapors. The HEPA filters are intended only to remove particulates and biological agents.
2. Never work in or near the hood with the ultraviolet light turned on. UV light can damage eyes and exposed skin very quickly. Only use the light for the minimum period of time necessary for disinfection, never more than 15 minutes. Note: NIH, CDC, and ABSA all discourage the use of UV for disinfection.
3. Work surfaces should be decontaminated with an appropriate disinfectant on a routine basis, after work with infectious materials is finished, and especially after spills, splashes, or other contamination by infectious materials.
4. If the unit is not left running continuously, turn the blower on and air purge for at least five minutes to remove airborne contamination before the next use.
5. Each laboratory should develop procedures which identify the hazards that will or may be encountered, and which specifies practices and procedures designed to minimize or eliminate risks.
6. Laboratory personnel must receive appropriate training on the potential hazards associated with the work involved, including the necessary precautions to prevent exposures, and the exposure evaluation procedures.
7. Annual BSC inspections are conducted to maintain proper air flow and certify the BSC for operation.

## 5.6 STANDARD REPAIR / CLOSE-OUT / DECOMMISSIONING PROCEDURES

When a request for equipment repair or transfer to another location is initiated, the following steps must be undertaken to ensure the safety of the employees responsible for repair or transfer:

1. Remove contaminants with an appropriate solvent or cleaning solution.
2. Once contaminants have been eliminated, place sign indicating decontamination status in a prominent position on the equipment to be repaired or transferred.

## 6.0 HAZARDOUS WASTE MANAGEMENT PLAN

Each laboratory has a designated space where hazardous waste is accumulated. Lab waste is collected in clearly labeled and tightly capped containers that are compatable with the waste. When the waste is ready for storage, it may be moved to the hazardous waste accumulation area. Follow the procedure found in department specific plans. (Labels are available from the Lab Supervisor.)

### 6.1 Waste Characterization

1. Each Principal Investigator or Lab Supervisor must identify and label each lab waste using instuctions provided by the CHO or department plan.
2. SHERM staff will assist Principal Investigators and Lab Supervisors with proper disposal procedures for wastes generated in the lab to ensure compliance with waste disposal requirements.

### 6.2 Container Management

1. Each lab must have appropriate containers and waste accumulation areas for waste identified in their lab.
2. Do not mix incompatible wastes.
3. Waste accumulated in the laboratory must be placed into containers that are in good condition, compatible with the contents, and able to be securely closed. Waste containers must be kept clean with no visible contamination on the outside of the container.
4. Waste containers must remain closed when not adding or removing waste.
5. Waste containers must be labeled with university provided hazardous waste label:
    a) Use a Sharpie or ball point pen to fill out the label.
    b) The labels must be filled out completely and written legibily.
    c) The date accumulation started and the name of the owner ofthe waste.
    d) Any other descriptions about the contents pertinent to the disposal facility. Provide as much detail as possible on the label such as chemical or common names.
    e) Attach additional supplemental information if necessary.
6. Labels must be visibly displayed so it can be read without physical contact with the container.
7. Areas where waste chemicals are accumulated must have secondary containment sufficient to collect any incidental spills from container failure. Containers should not be overfilled. Leave headspace to allow for expansion and store the filled waste containers in a secure area.

### 6.3 Waste Disposal

1. Hazardous waste is accumulated in the Hazardous Waste Storage areas for each FSU facility.

2. A licensed waste hauler is contracted to make hazardous waste pickups on a regular basis, according to state and federal regulations.

3. SHERM will track all Manifests and shipping documents
    a) SHERM or a SHERM designated person signs manifests.
    b) SHERM retains the ‘generator” copy and maintains manifest and shipping records.

4. Waste should be segregated and labeled.
    a) Clean broken glassware and non-infectious slides are stored in broken glass disposal boxes and may be disposed of in the general waste stream (regular trash).
    b) Chemical waste is to be collected in containers labeled with the Univeristry "Hazardous Waste" label.
    c) Waste mercury and mercury containing devises are placed in labeled leak proof containers with a sealed lid.
    d) Used batteries are placed in the battery recycling containers.
    e) Lamps and bulbs are are placed in labeled leak proof containers with a sealed lid.
    f) Sharps and infectious slides are placed in biohazardous sharps waste containers. The containers are red, labeled, rigid, leakproof, and puncture resistant.
    g) Other biohazardous waste is placed in biohazardous waste disposal bags.
    h) Biohazardous sharps containers and biohazardous waste disposal bags are placed in red biohazardous disposal totes for shipping.

# 7.0 EMERGENCY RESPONSE

## 7.1 BASIC STEPS FOR EMERGENCIES

See the FSU Emergency and Safety Procedures Guide at
https://www.ferris.edu/administration/adminandfinance/finance/sherm/Safety/pdfs-docs/FSU-FlipCharts.pdf

## 7.2 SPILL RESPONSE

### 7.3.1 Incidental Spills

Incidental spills are small quantities of material that you understand the hazards of and are comfortable that you have the training and ability and to clean up appropriately. If you are unsure of the hazard of a spill or proper response procedures contact your Lab Supervisor, CHO or Public Safety. All incidental spills should be cleaned up immediately.

Incidental spill cleanup procedures:

1. Notify everyone in the immediate area that you have a spill.
2. Assess the hazard and your ability to clean it up properly.
3. Locate the spill kit and identify appropriate protective equipment. At a minimum always use gloves and protective eyewear.
4. Use an appropriate absorbent to confine or contain the spill. Strong acids or bases may need to use a neutralizing absorbent. Do not use paper towels.
5. Contact SHERM or CHO for proper disposal.

### 7.3.2 Hazardous Material Incident

These may be larger in quantity or spills of highly hazardous materials including materials of low LD50, carcinogens or reproductive toxins, reactive, corrosive or flammable liquids, or metals, and materials of unknown toxicity.

Potentially hazardous spill response procedures

1. If toxic chemicals come into contact with your skin or eyes, immediately flush the affected area with clear water. Remove contaminated clothing.
2. Call 911 and give the Dispatcher a complete description of the incident.
3. Describe the type of accident: fire, explosion, spill, or leak.
4. Identify the building where the incident occurred and the room number or location of the incident.
5. If the incident involves a chemicals, give the approximate amount of the spill and inform Police/First Responders the name of the chemical if known.
6. Give your name and the telephone number from which you are calling.
7. Advise the Dispatcher of any injuries.
8. Don’t hang up until told to do so by the Dispatcher.
9. At a safe distance, await the arrival of Police/First Responders. Provide any additional information that they may require.
10. All chemical spills and fires, no matter how small, should be reported toFSU Police (591-5000) and Facilities Management (591-2920).

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

### 7.3.3 Mercury Spills

These spills are considered hazardous material incidents see section 7.3.2

These may occur when mercury-containing devices are broken. To avoid such spills from occurring all mercury containing devices should be replaced with a non-mercury substitute. In case of a spill or broken mercury containing device, notify campus police of the spill.

Mercury reductions plans must be followed for mercury containing devices or mercury containing chemicals. SCI, VFS and PHR are all under specific mercury reductions plans. The city of Big Rapids prohibits the discharge of mercury into the sewer.

For all potentially hazardous spills a report describing the spill should be sent to the area lab supervisor, and CHO.

### 7.3 POWER OUTAGES

The main risk during a power outage is loss of lab ventilation and climate control. Emergency lighting is provided for emergency egress. If emergency lighting and fire alarms ARE NOT operable, evacuate the building. If adequate lighting is provided, leave the area after the following steps have been taken. It is the responsibility of the lab supervisor/PI to ensure that each of the following occurs:

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

### 7.4 INJURY AND ILLNESS

For medical emergencies dial 911. For employees seeking non-emergency medical treatment, under current FSU policies and procedures, affected employees must seek care from an approved facility - list maintained by SHERM. Injured students seeking non-emergency medical attention are to make their own decisions regarding their medical care (see policy: https://www.ferris.edu/HTMLS/administration/buspolletter/treat.917.htm). The supervisor or instructor must ensure the appropriate injury report forms are completed. If you have any questions regarding injury and illness procedures, contact your supervisor or instructor.

Minor First Aid: In most situations emergency medical care is available within minutes of FSU labs.

1. Do not dispense or administer any medications, including aspirin.
2. Do not put any ointments or creams on wounds or burns. Use cool water.
3. Review the SDS for specific first aid information for a given chemical.

Eye Splash:

1. Remove victim from spill area only if an attempt to rescue does not present a danger to the rescuers.
2. Lead the victim(s) immediately to an emergency eyewash facility.
3. Assist the victim as needed. The goal is to flush the eyes and upper portion of the face.
4. Flush for at least 15 minutes or longer if pain persists.
5. Contact the CHO and/or emergency response personnel and inform them of the incident and possible chemical(s) involved.
6. Seek appropritate medical care as soon as possible.

Chemical Body Splash:

1. Remove victim(s) from the spill area to fresh air only if an attempt to rescue victim(s) does not present a danger to the rescuers.
2. Don appropriate personal protective equipment (gloves, eye protection, etc.)
3. Remove contaminated clothing while under an emergency shower.
4. Flush affected area of the body with coolwater for at least 15 minutes or longer if pain persists.
5. Do not use neutralizing chemicals, creams, lotions or salves.
6. Contact the CHO and/or emergency response personnel and inform them of the incident and possible chemical(s) involved.
7. Seek appropritate medical care as soon as possible.

## 8.0 MEDICAL CONSULTATIONS AND EXAMINATIONS

In certain situations, FSU will provide faculty, staff, and student employees, who work with hazardous materials an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

1. An employee must be provided an opportunity to receive an appropriate examination when he or she develops signs or symptoms associated with hazardous materials to which there may have been exposure in the laboratory.

2. If exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the Permissible Exposure Limit) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

3. Whenever an event takes place in the work area, such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultations shall be for determining the need for a medical examination.

All medical consultations and examinations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay and at a reasonable time and place.

The following information shall be provided to the examining physician:

1. The identity of the hazardous chemical(s) to which the employee may have been exposed.

2. A description of the conditions surrounding the exposure, including available quantitative exposure data.

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

SHERM shall obtain a written opinion from the examining physician that includes:

1. The results of the medical examination and any associated tests and any recommendation for further medical follow-up.

2. Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace.

3. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

4. The written opinion of the physician shall not reveal specific finding of diagnoses unrelated to occupational exposure.

Accident records for employees should be written and submitted to SHERM. Forms are available at www.ferris.edu/SHERM .

## 9.0 APPENDICES

Appendix A FSU Accident/Injury Report Form
Appendix B Incompatibility of Common Laboratory Chemicals
Appendix C Flammable & Combustible Liquid Containment & Storage Requirements
Appendix D Common Laboratory Corrosives
Appendix E Common Laboratory Oxidizers
Appendix F Common Peroxide Formers & Detection and Inhibition of Peroxides
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Appendix I Termination of Laboratory use of hazardous materials
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# APPENDIX A: FSU INCIDENT AND INJURY REPORT FORM

Employee injury report located at: https://www.ferris.edu/HTMLS/administration/adminandfinance/finance/sherm/pdfs-docs/IncidentReportForm.pdf; Non-employee/student injury report located at: https://www.ferris.edu/HTMLS/administration/adminandfinance/finance/sherm/pdfs-docs/student-injury.pdf

# APPENDIX B: INCOMPATIBILITY OF COMMON LABORATORY CHEMICALS

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

1. Flammable/Combustible Liquids and Organic Acids
2. Flammable Solids
3. Mineral Acids
4. Caustics
5. Oxidizers
6. Perchloric Acid
7. Compressed Gases

Before mixing any chemicals, refer to this partial list, the chemicals' SDS's, or contact the Chemical Hygiene Officer to verify compatibility:

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

| | |
|---|---|
| **Hydroperoxide** | reducing agents |
| **Cyanides** | acids, alkaloids, aluminum, iodine, oxidizers, strong bases |
| **Flammable liquids** | ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens |
| **Fluorine** | alcohol's, aldehydes, ammonia, combustible materials, halocarbons, halogens, hydrocarbons, ketones, metals, organic acids |
| **Hydrocarbons (Such as butane, propane benzene, turpentine, etc.)** | acids, bases, oxidizers, plastics |
| **Hydrofluoric acid** | metals, organic materials, plastics, silica (glass), (anhydrous) sodium |
| **Hydrogen peroxide** | acetylaldehyde, acetic acid, acetone, alcohol's carboxylic acid, combustible materials, metals, nitric acid, organic compounds, phosphorous, sulfuric acid, sodium, aniline |
| **Hydrogen sulfide** | acetylaldehyde, metals, oxidizers, sodium |
| **Hypochlorites** | acids, activated carbon |
| **Iodine** | acetylaldehyde, acetylene, ammonia, metals, sodium |
| **Mercury** | acetylene, aluminum, amines, ammonia, calcium, fulminic acid, lithium, oxidizers, sodium |
| **Nitrates** | acids, nitrites, metals, sulfur, sulfuric acid |
| **Nitric acid** | acetic acid, acetonitrile, alcohol's, amines, (concentrated) ammonia, aniline, bases, benzene, cumene, formic acid, ketones, metals, organic materials, plastics, sodium, toluene |
| **Oxalic acid** | oxidizers, silver, sodium chlorite |
| **Oxygen** | acetaldehyde, secondary alcohol's, alkalis and alkalines, ammonia, carbon monoxide, combustible materials, ethers, flammable materials, hydrocarbons, metals, phosphorous, polymers |
| **Perchloric acid** | acetic acid, alcohols, aniline, combustible materials, dehydrating agents, ethyl benzene, hydriotic acid, hydrochloric acid, iodides, ketones, organic material, oxidizers, pyridine |
| **Peroxides, organic** | acids (organic or mineral) |
| **Phosphorus (white)** | oxygen (pure and in air), alkalis |
| **Potassium** | acetylene, acids, alcohols, halogens, hydrazine, mercury, oxidizers, selenium, sulfur |
| **Potassium chlorate** | acids, ammonia, combustible materials, fluorine, hydrocarbons, metals, organic materials, sugars |
| **Potassium perchlorate (also see chlorates)** | alcohols, combustible materials, fluorine, hydrazine, metals, organic matter, reducing agents, sulfuric acid |
| **Potassium permanganate** | benzaldehyde, ethylene glycol, glycerol, sulfuric acid |
| **Silver** | acetylene, ammonia, oxidizers, ozonides, peroxyformic acid |
| **Sodium** | acids, hydrazine, metals, oxidizers, water |
| **Sodium nitrate** | acetic anhydride, acids, metals, organic matter, peroxyformic acid, reducing agents |
| **Sodium peroxide** | acetic acid, benzene, hydrogen sulfide metals, oxidizers, peroxyformic acid, phosphorous, reducers, sugars, water |
| **Sulfides** | Acids |
| **Sulfuric acid** | potassium chlorates, potassium perchlorate, potassium permanganate |

**References:**

Safety Data Sheets, various chemical companies.

NIH Compatibility Chart - https://ors.od.nih.gov/sr/dohs/Documents/General_Chemical_Storage_Compatibility_Chart.pdf

# APPENDIX C: FLAMMABLE AND COMBUSTIBLE STORAGE AND CONTAINMENT

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

| Chemical | Flash Point | | Boiling Point | | NFPA Class |
|---|---|---|---|---|---|
| | ° F | ° C | ° F | ° C | |
| Acetaldehyde | -38 | -39 | 69 | 21 | IA |
| Dimethyl sulfide | -36 | -38 | 99 | 37 | IA |
| Ethyl ether | -49 | -45 | 95 | 35 | IA |
| Ethylene oxide | -20 | -29 | 55 | 13 | IA |
| Pentane | -57 | -49 | 97 | 36 | IA |
| Propane | -157 | -105 | -44 | -42 | IA |
| Benzene | 12 | -11 | 176 | 80 | IB |
| Carbon disulfide | -22 | -30 | 115 | 46 | IB |
| Cyclohexane | -4 | -20 | 179 | 81 | IB |
| Ethyl alcohol | 55 | 13 | 173 | 78 | IB |
| n-Hexane | -7 | -22 | 156 | 69 | IB |
| Isopropyl alcohol | 53 | 12 | 180 | 82 | IB |
| Methyl alcohol | 52 | 11 | 149 | 65 | IB |
| Methyl ethyl ketone | 16 | -9 | 176 | 80 | IB |
| Pyridine | 68 | 20 | 239- | 116 | IB |
| Tetrahydrofuran | 6 | -14 | 153 | 67 | IB |
| Toluene | 40 | 4 | 231 | 111 | IB |
| Triethylamine | 20 | -7 | 193 | 89 | IB |
| tert Butyl isocyanate | 80 | 27 | 185- | 85-86 | IC |
| | | | | | |

| Chemical | Flash Point | | Boiling Point | | NFPA Class |
|---|---|---|---|---|---|
| | ° F | ° C | ° F | ° C | |
| Chlorobenzene | 82 | 28 | 270 | 132 | IC |
| Epichlorohydrin | 88 | 31 | 239- | 115- | IC |
| 2-Nitropropane | 75 | 24 | 248 | 120 | IC |
| Xylene | 81-90 | 27- | 280- | 138- | IC |
| Acetic Acid, glacial | 103 | 39 | 244 | 48 | II |
| Bromobenzene | 118 | 48 | 307- | 153- | II |
| Formic Acid | 156 | 69 | 213 | 101 | II |
| Morpholine | 100 | 38 | 263 | 128 | II |
| Stoddard Solvent | 100- | 38- | 300- | 150- | II |
| Benzaldehyde | 145 | 63 | 352 | 178 | IIIA |
| Cyclohexanol | 154 | 68 | 322 | 161 | IIIA |
| Methacrylic Acid | 170 | 77 | 316 | 158 | IIIA |
| Nitrobenzene | 190 | 88 | 412 | 211 | IIIA |
| Tetrahydronaphthalene | 160 | 71 | 406 | 208 | IIIA |
| Benzyl Alcohol | 213 | 101 | 401 | 205 | IIIB |
| Caproic Acid | 215 | 102 | 400 | 204 | IIIB |
| Ethylene Glycol | 232 | 111 | 388 | 198 | IIIB |
| Phenyl Ether | 239 | 115 | 498 | 258 | IIIB |
| Stearic Acid | 385 | 196 | 726 | 386 | IIIB |

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

## Flammable and Combustible Liquid Containment and Storage Requirements

### Containment:

Only approved containers and metal portable tanks authorized by NFPA 30 shall be used to store flammable liquids.

| | Flammable Class | | | Combustible Class | |
|---|---|---|---|---|---|
| **Container** | **IA** | **IB** | **IC** | **II** | **III** |
| Glass | 1 pt* | 1 qt* | 1 gal | 1 gal | 5 gal |
| Metal or Approved Plastic | 1 gal | 5 gal | 5 gal | 5 gal | 5 gal |
| Safety Cans | 2 gal | 5 gal | 5 gal | 5 gal | 5 gal |
| Metal Drums | 60 gal | 60 gal | 60 gal | 60 gal | 60 gal |
| Approved Metal Portable Tanks | 660 gal | 660 gal | 660 gal | 660 gal | 660 gal |
| Polyethylene | 1 gal | 5 gal | 5 gal | 60 gal | 60 gal |

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

## Storage

Only NFPA 45 approved amounts of flammable liquids shall be stored in laboratory units outside of flammable liquid storage rooms.

| Flammable / Combustible Class | Maximum Quantity per 100ft$^2$ of Laboratory Unit | Maximum Quantity per Laboratory Unit | |
|---|---|---|---|
| List as Class A Lab | | Unsprinklered | Sprinklered |
| I | 20 gallons | 600 gallons | 1200 gallons |
| I, II and IIIA | 40 gallons | 800 gallons | 1600 gallons |
| List as Class B Lab | | | |
| I | 10 gallons | 300 gallons | 600 gallons |
| I, II and IIIA | 20 gallons | 400 gallons | 800 gallons |
| List as Class C Lab | | | |
| I | 4 gallons | 150 gallons | 300 gallons |
| I, II and IIIA | 8 gallons | 200 gallons | 400 gallons |

- The amounts above include quantities stored in approved storage cabinets and safety cans. Allowable quantities stored outside of approved storage cabinets and safety cans are 50% of the quantities listed above.
- Laboratories listed as Class A shall be considered high hazard laboratories and **shall not be used as instructional laboratories.**
- Laboratories listed as Class B shall be considered intermediate hazard laboratories.
- Laboratories listed as Class C shall be considered low hazard laboratories.
- **Should Class B or C laboratories be used for instructional purposes, quantities of flammable and combustible liquids shall be 50% of those listed in the above table.**

# APPENDIX D: COMMON LABORATORY CORROSIVES

| ORGANIC ACIDS | ORGANIC BASES | INORGANIC ACIDS |
|---|---|---|
| Formic Acid | Ethylenediamine | Hydrofluoric Acid |
| Acetic Acid (Glacial) | Ethylimine | Hydrochloric Acid |
| Propionic Acid | Tetramethylethylenediamine | Hydrobromic Acid |
| Butyric Acid | Hexamethylenediamine | Hydriotic Acid |
| Chloroacetic Acid | Trimethylamine aq. soln. | Sulfuric Acid |
| Trichloroacetic Acid | Triethylamine | Chromerge™ |
| Acetyl Chloride | Phenylhydrazine | No-Chromix™ |
| Acetyl Bromide | Piperazine | Chlorosulfonic Acid |
| Chloroacetyl Chloride | Hydroxylamine | Sulfuryl Chloride |
| Oxalic Acid | Tetramethylammonium Hydroxide | Bromine Pentafluoride |
| Propionyl Chloride | | Thionyl Chloride |
| Propionyl Bromide | **ELEMENTS** | Tin Chloride |
| Acetic Anhydride | Fluorine (gas) | Tin Bromide |
| Methyl Chloroformate | Chlorine (gas) | Titanium Tetrachloride |
| Dimethyl Sulfate | Bromine (liquid) | Perchloric Acid |
| Chlorotrimethylsilane | Iodine (crystal) | Nitric Acid |
| Dichlorodimethylsilane | Phosphorus | Phosphoric Acid |
| Phenol | | Phosphorus Trichloride |
| Benzoyl Chloride | | Phosphorus Tribromide |
| Benzoyl Bromide | **INORGANIC BASES** | Phosphorus Pentachloride |
| Benzyl Chloride | Ammonium Hydroxide | Phosphorus Pentoxide |
| Benzyl Bromide | Calcium Hydroxide | |
| Salicylic Acid | Sodium Hydroxide | |
| | Potassium Hydroxide | **ACID SALTS** |
| | Calcium Hydride | Aluminum Trichloride |
| | Sodium Hydride | Antimony Trichloride |
| | Hydrazine | Ammonium Bifluoride |
| | Ammonium Sulfide | Calcium Fluoride |
| | Calcium Oxide | Ferric Chloride |
| | | Sodium Bisulfate |
| | | Sodium Fluoride |

References:

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

# APPENDIX E: COMMON LABORATORY OXIDIZERS

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

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

# APPENDIX F: PEROXIDIZABLE CHEMICALS

## Part A. Chemicals that form explosive levels of peroxides without concentration

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

## Part B. Chemicals that form explosive levels of peroxides on concentration

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

## Part C. Chemicals that may autopolymerize because of peroxide accumulation

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

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

| | | | |
|---|---|---|---|
| Acrolein | tert-Butyl methyl ether | Di(1-propynyl) ether[f] | 4-Methyl-2-pentanone |
| Allyl ether[d] | n-Butyl phenyl ether | Di(2-propynyl) ether | n-Methylphenetole |
| Allyl ethyl ether | n-Butyl vinyl ether | Di-n-propoxymethane[d] | 2-Methyltetrahydrofuran |
| Allyl phenyl ether | Chloroacetaldehyde diethylacetal[d] | 1,2-Epoxy-3-isopropoxypropane[d] | 3-Methoxy-1-butyl acetate |
| p-(n-Amyloxy)benzoyl chloride | 2-Chlorobutadiene | 1,2-Epoxy-3-phenoxypropane | 2-Methoxyethanol |
| n-Amyl ether | 1-(2-Chloroethoxy)-2-phen-oxyethane | Ethoxyacetophenone | 3-Methoxyethyl acetate |
| Benzyl n-butyl ether[d] | | 1-(2-Ethoxyethoxy)ethyl acetate | 2-Methoxyethyl vinyl ether |
| Benzyl ether[d] | Chloroethylene | 2-Ethoxyethyl acetate | Methoxy-1,3,5,7-cycloocta Tetraene |
| Benzyl ethyl ether[d] | Chloromethyl methyl ether[e] | (2-Ethoxyethyl)-o-benzoyl Benzoate | |
| Benzyl methyl ether | §-Chlorophenetole | | §-Methoxypropionitrile |
| Benzyl 1-naphthyl ether[d] | o-Chlorophenetole | 1-Ethoxynaphthalene | m-Nitrophenetole |
| 1,2-Bis(2-chloroethoxy)ethane | p-Chlorophenetole | o,p-Ethoxyphenyl isocyanate | 1-Octene |
| Bis(2-ethoxyethyl) ether | Cyclooctene[d] | 1-Ethoxy-2-propyne | Oxybis(2-ethyl acetate) |
| Bis(2-(methoxyethoxy)ethyl) ether | Cyclopropyl methyl ether | 3-Ethoxyopropionitrile | Oxybis(2-ethyl benzoate) |
| | Diallyl ether[d] | 2-Ethylacrylaldehyde oxime | §,§-Oxydipropionitrile |
| Bis(2-chloroethyl) ether | p-Di-n-butoxybenzene | 2-Ethylbutanol | 1-Pentene |
| Bis(2-ethoxyethyl) adipate | 1,2-Dibenzyloxyethane[d] | Ethyl §-ethoxypropionate | Phenoxyacetyl chloride |

| | | | |
|---|---|---|---|
| Bis(2-ethoxyethyl) phthalate | p-Dibenzyloxybenzene[d] | 2-Ethylhexanal | Œ-Phenoxypropionyl chloride |
| Bis(2-methoxyethyl) carbonate | 1,2-Dichloroethyl ethyl ether | Ethyl vinyl ether | Phenyl o-propyl ether |
| Bis(2-methoxyethyl) ether | 2,4-Dichlorophenetole | Furan p-Phenylphenetone | |
| Bis(2-methoxyethyl)phthalate | Diethoxymethane[d] | 2,5-Hexadiyn-1-ol | n-Propylether |
| Bis(2-methoxymethyl) adipate | 2,2-Diethoxypropane | 4,5-Hexadien-2-yn-1-ol | n-Propyl isopropyl ether |
| Bis(2-n-butoxyethyl) phthalate | Diethyl ethoxymethylenemalonate | n-Hexyl ether | Sodium 8,11,14-eicosa Tetraenoate |
| Bis(2-phenoxyethyl) ether | Diethyl fumarated | o,p-Iodophenetole | |
| Bis(4-chlorobutyl) ether | Diethyl acetal[d]Isoamyl benzyl ether[d] | Sodium ethoxyacetylide[f] | |
| Bis(chloromethyl) ether[e] | Diethylketene[f] | Isoamyl ether[d] | Tetrahydropyran |
| 2-Bromomethyl ethyl ether | m,o,p-Diethoxybenzene | Isobutyl vinyl ether | Triethylene glycol diacetate |
| §-Bromophenetole | 1,2-Diethoxyethane | Isophorone[d] | Triethylene glycol dipropionate |
| o-Bromophenetole | Dimethoxymethane[d] | p-Isopropoxypropionitrile[d] | 1,3,3-Trimethoxypropene[d] |
| p-Bromophenetole | 1,1-Dimethoxyethane[d] | Isopropyl 2,4,5-trichlorophenoxy-Acetate | 1,1,2,3-Tetrachloro-1,3-Butadiene |
| 3-Bromopropyl phenyl ether | Dimethylketene[f] | | |
| 1,3-Butadiyne | 3,3-Dimethoxypropene | Limonene | 4-Vinyl cyclohexene |
| Buten-3-yne | 2,4-Dinitrophenetole | 1,5-p-Methadiene | Vinylenecarbonate |
| tert-Butyl ethyl ether | 1,3-Dioxepane[d] | Methyl p-(n-amyloxy)benzoate | Vinylidene chioride[d] |

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

**Safe Storage Period for Peroxide Forming Chemicals**

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

****Do not store under inert atmosphere, oxygen required for inhibitor to function.****

## DETECTION AND INHIBITION OF PEROXIDES BASIC PROTOCOLS

### Ferrous Thiocyanate Detection Method

Ferrous thiocyanate will detect hydroperoxides with the following test:

1. Mix a solution of 5 ml of 1 % ferrous ammonium sulfate, 0.5 ml of 1 N sulfuric acid and 0.5 ml of 0.1 N ammonium thiocyanate (if necessary decolorize with a trace of zinc dust)
2. Shake with an equal quantity of the solvent to be tested

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

## Potassium Iodide Detection Method

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

## Inhibition of Peroxides

1. Storage and handling under an inert atmosphere is a useful precaution
2. Addition of 0.001 % hydroquinone, diphenylamine, polyhydroxyphenols, aminophenols, or arylamines may stabilize ethers and inhibit formation of peroxides.
3. Dowex-1$^{R}$ has been reported effective for inhibiting peroxide formation in ethyl ether.
4. 100 ppm of 1-naphthol effective for peroxide inhibition in isopropyl ether.
5. Hydroquinone effective for peroxide inhibition in tetrahydrofuran.
6. Stannous chloride or ferrous sulfate effective for peroxide inhibition in dioxane.

## Peroxides Test Strips

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

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

Sources:


1. Furr, Keith Handbook of Lab Safety, 4$^{th}$ ed., CRC Press, 1995
2. Kelly, Richard J., Review of Safety Guidelines for Peroxidizable Organic Chemicals, Chemical Health & Safety, American Chemical Society, Sept./Oct. 1996
3. Sources: Kelly, Richard J., Chemical Health & Safety, American Chemical Society, **1996**, Sept, 28-36Revised 12/97

# APPENDIX G: SHOCK SENSITIVE AND EXPLOSIVE CHEMICALS

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

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

| | | |
|---|---|---|
| acetylene | fulminate of mercury | nitroguanidine |
| acetylides of heavy metal | fulminate of silver | nitroparaffins |
| amatex | ethylene oxide | nitrourea |
| amatol | ethyl-tetryl | organic nitramines |
| ammonal | fulminating gold | ozonides |
| ammonium nitrate | fulminating mercury | pentolite |
| ammonium perchlorate | fulminating platinum | perchlorates of heavy metals |
| ammonium picrate | fulminating silver | peroxides |
| azides of heavy metals | gelatinized nitrocellulose | picramic acid |
| baratol | Guanyl | picramide |
| calcium nitrate | guanyl nitrsamino | picratol |
| chlorate | Guanyltetrazene | picric acid |
| copper acetylide | Hydrazine | picryl sulphonic acid |
| cyanuric triazide | nitrated carbohydrate | silver acetylide |
| cyclotrimethylenetrinitramine | nitrated glucoside | silver azide |
| dinitrophenol | nitrogen triiodide | tetranitromethane |
| dinitrophenyl hydrazine | nitrogen trichloride | |
| dinitrotoluene | Nitroglycerin | |
| ednatol | Nitroglycide | |
| erythritol tetranitrate | Nitroglycol | |
| **Mixtures:** | | |
| germanium | Tetracene | |
| hexanitrodiphenyamine | Tetrytol | |
| hexanitrostilbene | Trimethylolethane | |
| hexogen | Trimonite | |
| hydrazoic acid | Trinitroanisole | |
| lead azide | Trinitrobenzene | |
| lead mononitroresorcinate | trinitrobenzoic acid | |
| lead styphnate | Trinitrocresol | |
| mannitol hexanitrate | Trinitroresorcinol | |
| sodium picramate | Tritonal | |
| tetranitrocarbazole | urea nitrate | |

References: Safety Data Sheets, various chemical companies

# **APPENDIX H:** FSU CHEMICAL SAFETY LABORATORY CHECKLIST

FERRIS STATE UNIVERSITY – LAB SAFETY INSPECTION CHECKLIST

| Principal Investigator/Faculty | Department | Location (Room & Bldg.): | Inspected By: | Date: |
|---|---|---|---|---|
| | | | | |
| Description of Lab Operations: | | | | |

General Safety

| Item | Description | Yes | No | N/A |
|---|---|---|---|---|
| 1 | Chemical inventory and SDS's maintained and up-to-date. | | | |
| 2 | Current emergency contact information posted in the Information Management System. | | | |
| 3 | A telephone or cell phone is available and emergency contact numbers are posted in the lab | | | |
| 4 | The PI, paid employees, and research staff have completed Lab Safety Training | | | |
| 5 | The PI has evaluated the hazards associated with the procedures, chemicals, and equipment in the lab and, where needed, has made standard operating procedures available to lab staff | | | |
| 6 | The PI provides adequate supervision to research staff, reports all accidents/injuries to CHO | | | |
| 7 | No food and beverages rules are observed | | | |
| 8 | Hand sink (w/ soap), first aid kit and spill kit are available | | | |
| 9 | Special hazards (UV, radiation, biohazards, lasers, etc) clearly identified upon entering the lab | | | |

Housekeeping & Fire Protection

| | | | | |
|---|---|---|---|---|
| 10 | Laboratory work surfaces, floors, and storage areas are clean and uncluttered | | | |
| 11 | Unobstructed access to exits, fire extinguishers, safety showers and eyewashes | | | |
| 12 | Electrical cords in good condition, no permanent extension cords, and properly grounded | | | |
| 13 | Sprinkler heads are unobstructed and in good condition | | | |
| 14 | Glassware and equipment are in good condition and free from defects | | | |
| 15 | Flammable materials are stored away from ignition sources | | | |
| 16 | Bulk quantities of flammables stored in flammable storage cabinets | | | |

Chemical Storage

| | | | | |
|---|---|---|---|---|
| 17 | All containers are labeled, in good condition, and not leaking | | | |
| 18 | Incompatible materials are segregated | | | |
| 19 | Corrosives and flammables stored below eye level | | | |
| 20 | Peroxide forming agents dated and disposed or tested if past the expiration date | | | |
| 21 | Bench storage of chemicals kept to a minimum | | | |
| 22 | Unnecessary, unused, or outdated materials are removed from labs or storage areas | | | |
| 23 | Cylinders properly secured, stored (fuel & oxygen separated, away from heat), labeled with contents or "empty", and capped when not in use. Hoses and connections in good condition. | | | |
| 24 | Refrigerators storing flammable materials are designed for use with flammable materials | | | |
| 25 | No toxic or poisonous gasses used | | | |
| 26 | Particularly hazardous substances (high acute/chronic toxicity, infectious agents, select carcinogens, reproductive toxins, etc.) are properly identified and stored | | | |

Personal Protection

| | | | | |
|---|---|---|---|---|
| 27 | Eye protection and appropriate gloves are available and properly used in all laboratories | | | |
| 28 | Proper dress and closed-toed footwear rules are enforced, lab coats available if necessary | | | |
| 29 | Safety showers & eyewashes are appropriately located and tested | | | |
| 30 | The PI has developed policies for working alone and unattended operations | | | |
| 31 | Fume hoods are operating properly, inspected annually, clean, and not used for storage | | | |
| 32 | Biosafety cabinet is clean, inspected in the past 12 months, UV off | | | |

Waste Handling

| | | | | |
|---|---|---|---|---|
| 33 | Staff have made determinations for proper disposal of all waste streams generated in the lab | | | |
| 34 | Waste streams are separated (ex: halogenated solvents, corrosives, liquid or solid, biological) | | | |
| 35 | Hazardous waste containers are clearly labeled and closed when not in use | | | |

| | | | | |
|---|---|---|---|---|
| 36 | Syringes and other sharp waste is disposed in a biohazardous sharps container | | | |

## APPENDIX I: TERMINATION OF LABORATORY USE OF HAZARDOUS MATERIALS

Whenever a Laboratory Supervisor (or a person under their charge performing work with hazardous materials in their laboratory) leaves the university or is transferred to a different location, proper disposition of hazardous materials is required. SHERM will coordinate with the CHO and lab supervisor/PI for disposals. This includes faculty, staff, post-doctoral and graduate students.

If improper management of hazardous materials at closeout requires removal services from an outside contractor, the responsible department will be charged for this service.

### Hazardous Chemical Disposal in Laboratories and Containment Areas

The following procedures should be completed before the responsible individual leaves the university or transfers to a different location on campus.

- Assure that all containers of chemicals are labeled with the name of the chemical. All containers must be securely closed. Beakers, flasks, evaporating dishes, etc., should be emptied. Hazardous chemical wastes must not be sewered or trashed; they must be collected for disposal.
- Clean chemicals from glassware and assure proper waste disposal guidelines are followed. Never pour chemical residues down the sink unless it is specified by the Chemical Hygiene Officer that this is the safe and preferred method of disposal.
- Check refrigerators, freezers, fume hoods, storage cabinets, and bench tops for chemical containers and thoroughly clean these locations.
- If another room or facility (such as a freezer or refrigerator, stock rooms, etc.) is shared with other researchers, remove, transfer, or dispose of items used by the departing researcher.
- Contact the Chemical Hygiene Officer for pick-up of hazardous waste at least one week prior to vacating the lab.
- For gas cylinders, remove regulators, replace cap and return to supplier. Gas cylinders used in the containment area must be decontaminated prior to return.

As an alternative to disposal, if the chemical is still usable, transfer the responsibility of the chemical to a supervisor who is willing to take charge of the chemical.

Follow all guidelines for disposal of unwanted chemicals. Hazardous waste chemicals should be placed in the Hazardous waste disposal room, provided:

- All chemical containers are properly labeled as "hazardous waste"
- All containers are securely closed.

Notify the department when laboratories or containment area/rooms have been cleared.

### Transportation of Chemicals on Campus

The following procedures should be completed by individuals who have usable chemicals that are to be moved to a different laboratory.

- Assure that all containers of chemicals are labeled with the name of the chemical. All containers must be securely closed. Beakers, flasks, evaporating dishes, etc., should be emptied. Stock solutions should be transferred to containers intended for use in transportation such as screw cap bottles. Transportation requirements for usable chemicals are the same as that for hazardous waste.
- Chemicals offered for shipment must be grouped together on lab benches or on shelves to facilitate removal.
- For gas cylinders, remove regulators and replace cap. Attach a tag with the name of the person responsible for the material, a contact person, and a phone number.
- A licensed transporter should be contacted to package and deliver the materials to the new location. The Chemical Hygiene Officer will help in making a proper selection.
- Individuals should not transport chemical materials themselves and should contact the Chemical Hygiene Officer for assistance.

## Disposal of Controlled Substances

The United States Drug Enforcement Agency (DEA) issues permits for controlled substances. There are several considerations when disposing of controlled substances.

- Abandonment of a controlled substance is a violation of the DEA permit under which it is held.
- Permission to transfer ownership of a controlled substance must be received from the DEA.
- If controlled substances for which the licensee is unknown are found, contact the Chemical Hygiene Officer.
- Controlled substances being held by a licensed individual and to be surrendered for destruction must be inventoried as required by the DEA.
- The disposal of controlled substances is coordinated by SHERM and involves the hazardous waste vendor's reverse dispensing program or return to the supplier.

## Disposal of Biological Materials

### Animal Tissue

- If tissue is held in a liquid preservative, the tissue and liquid should be separated.
- Animal parts and tissues should be placed in a biohazard waste bag for disposal by licensed disposal company.
- Liquid preservatives usually needs to be disposed as a hazardous waste. Contact SHERM for assistance. Do not assume that the preservative can be sewered.
- If appropriate disposal is uncertain, contact SHERM.
- Defrost and clean refrigerators and freezers if they are empty.
- If samples need to be saved, locate the supervisor to take responsibility for them.

### Microorganisms and Cultures

- Use an autoclave to decontaminate all liquid culture waste, and dispose of it as the policy states.
- If the material cannot be decontaminated, place it in a biohazard bag for disposal by licensed disposal company
- Clean and disinfect incubators, drying or curing ovens, refrigerators and freezers.
- If samples need to be saved, locate the supervisor to take responsibility for them.

## Transportation of Biological Materials

Transportation of infectious materials should be avoided.
All biological materials* that are of potential risk to humans and/or animals must be stored and transported in a primary and secondary container. Primary containers can be culture tubes, flasks, vials etc. All containers must meet the following requirements:

- Rigid
- Puncture resistant
- Leak proof
- Impervious to moisture
- Of sufficient strength to prevent tearing or bursting under normal conditions of use and handling
- Sealed to prevent leakage during transport
- Labeled with a biohazard or infectious substance label

All containers should be accompanied by a list of content, the person responsible for this material, a contact person and phone number.

If materials are to be transported in liquid nitrogen or with other protection from ambient or higher temperatures, all containers and packaging should be capable of withstanding very low temperatures, and both primary and secondary packaging must be able to withstand a pressure differential of at least 95 kPa and temperatures in the range of -40 ° C to +50 ° C. If the material is perishable, warnings should appear on accompanying documents, e.g., "Keep cool, between +2 ° C and +4 ° C."

Contact SHERM for shiping requirements for biological materials.

*** Infectious substances:** viable microorganisms, including a bacterium, virus, rickettsia, fungus, or a recombinant, hybrid or mutant, that are known or reasonably believed to cause disease in animals or humans.

*** Diagnostic specimens:** any human or animal material including but not limited to, excreta, secreta, blood and its components, tissue and tissue fluids.

## Radioisotopes

For appropriate close out procedures for Radioactive Materials, please contact the Radiation Safety Officer.

## Equipment

If laboratory equipment is to be left for the next occupant, clean or decontaminate it before departing the laboratory. If exhaust or filtration equipment has been used with extremely hazardous substances or organisms, alert the Chemical Hygiene Officer.

If laboratory equipment is to be discarded, be aware that capacitors, transformers, mercury switches, mercury thermometers, radioactive sources, and chemicals must be removed before disposal. Contact the Chemical Hygiene Officer for assistance. See policy regarding disposal of surplus University property: https://www.ferris.edu/HTMLS/administration/buspolletter/financial/Disposal-of-Surplus-University-Property.pdf.

Equipment potentially contaminated with radioisotopes must be surveyed by the Radiation Safety Officer prior to release or use by other persons.

## Shared Storage Areas

One of the most problematic situations is the sharing of storage units such as refrigerators, freezers, cold rooms, stock rooms, waste collection areas, etc., particularly if no one has been assigned to manage the unit. Departing researchers must carefully survey any shared facility in order to locate and appropriately dispose of their hazardous materials.

## Regulatory Impact

Mishandling of hazardous materials can result in citations, fines, and/or loss of right to use hazardous materials. Adverse publicity is also a frequent result.

# APPENDIX J: INDUSTRIAL TOXICOLOGY – OVERVIEW

## Chemical Toxicology

- Toxicology: The study of the nature and action of chemical poisons.
- Toxicity: The ability of a chemical molecule or compound to injure a susceptible site in or on the body.
- Toxicity hazard: The probability that injury will occur considering the manner in which the substance is used.

## Dose-Response Relationship

The potential toxicity (harmful action) of a substance is exhibited only when that substance comes in contact with a biological system. A chemical that may seem "harmless" may evoke a toxic response if added to a biological system in sufficient amount. The toxicity of a chemical is defined by the response that is produced in a biological system.

## Routes of Entry into the Body

1. Inhalation: Absorption through the respiratory tract. Most important in terms of severity.
2. Skin absorption or absorption through the mucous membranes.
3. Ingestion: Absorption through the digestive tract. Can occur through eating or smoking with contaminated hands or in contaminated work areas.
4. Injection: Introduction of toxin into bloodstream; can occur by needle stick or skin puncture by a sharp object.

## Exposure Limits as Related to Routes of Entry

- Most exposure standards are based on the inhalation route of exposure. They are normally expressed in terms of parts per million (ppm) or milligrams per cubic meter (mg/m) concentration in air.
- The Occupational Safety and Health Administration (OSHA) have established Permissible Exposure Limits (PELs) and the American Conference of Governmental Industrial Hygienists (ACGIH) has established Threshold Limit Values (TLV's) for employee exposure limits. Often the PEL and TLV are the same number. In the instances where one is lower than the other, it is prudent to maintain exposures at the lowest level achievable.
- If a significant route of exposure for a substance is through skin contact, the TLV or PEL will have a "skin" notation. Examples are pesticides, carbon tetrachloride, cyanides, ethylenediamine, and thallium.
- For a more complete list of PEL's and TLV's see the ACGIH publication "Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices." The latest editions list both TLV's and PELs.

## Types of Effects

- **Acute poisoning** is characterized by rapid absorption of the substance when the exposure is sudden and severe. Normally, a single large exposure is involved. Examples are carbon monoxide or cyanide poisoning.
- **Chronic poisoning** is characterized by prolonged or repeated exposures over time. Symptoms may not be immediately apparent. Examples are lead or mercury poisoning, or pesticide exposure.
- **Local** refers to the site of action of an agent where the action takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, gastrointestinal system, eyes, etc. Absorption does not necessarily occur. Examples are strong acids or alkalis.
- **Systemic** refers to a site of action other than the point of contact and presupposes absorption has taken place. For example, an inhaled material may act on the liver. For example, inhaled benzene affects the bone marrow.
- **Cumulative poisons** are characterized by materials that tend to build up in the body as a result of numerous chronic exposures. The effects are not seen until a critical body burden is reached. Examples are heavy metals.
- **Synergistic or potentiating** effects occur when two or more hazardous materials present at the same time have a resulting action greater than the effect predicted based on the individual substances. For example, workers exposed to benzene may show a direct toxicity in hematopoietic tissue and therefore be more susceptible to oxygen-displacing agents such as carbon monoxide.

## Other Factors Affecting Toxicity

- **Rate of entry and route of exposure** - how fast the toxic dose is delivered and by what means.
- **Age** - can affect the capacity to repair damaged tissue.
- **Previous exposure** - can lead to tolerance, increased sensitivity, or make no difference.
- **State of health, medications, physical condition, and life style**: Pre-existing disease can result in increased sensitivity.
- **Environmental factors** - temperature and pressure, for example, can affect exposure.

- **Host factors** - genetic predisposition and the sex of the exposed individual.

## Physical Class Effects on Toxicity

When considering the toxicity of gases and vapors, the **solubility of the substance** is a key factor. Highly soluble materials like ammonia irritate the upper respiratory tract. On the other hand, relatively insoluble materials like nitrogen dioxide penetrate deep into the lung. Fat-soluble materials, like pesticides, tend to have longer residence times in the body.

An **aerosol** is composed of solid or liquid particles of microscopic size dispersed in a gaseous medium. The toxic potential of an aerosol is only partially described by its concentration in milligrams per cubic meter ($mg/m^3$). For a proper assessment of the toxic hazard, the size of the aerosol's particles is important. Particles above 1 micrometer tend to deposit in the upper respiratory tract. Particles less than 1 micrometer in diameter enter the lung. Very small particles (< 0.2 5m) are generally not deposited.

## Physiological Classifications of Toxic Materials

**Irritants** are materials that cause inflammation of mucous membranes with which they come in contact. Inflammation of tissue results from concentration far below those needed to cause corrosion. Long-term exposure to irritants can result in increased mucous secretions and chronic bronchitis. Examples include:

| | | | |
|---|---|---|---|
| ammonia | phosgene | alkaline dusts - mists | diethyl sulfate |
| hydrogen chloride | nitrogen dioxide | hydrogen fluoride | Dimethyl sulfate |
| halogens | Arsenic trichloride | Ozone | phosphorus chlorides |

Irritants can also cause changes in the mechanics of respiration and lung function. Examples include:

| | | | |
|---|---|---|---|
| sulfur dioxide | iodine | acetic acid | sulfuric acid |
| formaldehyde | acrolein | formic acid | |

A **primary irritant** exerts no systemic toxic action because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is far in excess of any systemic toxic action. Example: hydrogen chloride.

A **secondary irritant's** effect on mucous membranes is over-shadowed by a systemic effect resulting from absorption. Examples include hydrogen sulfide or aromatic hydrocarbons. Exposure to a secondary irritant can result in pulmonary edema, hemorrhage, and tissue necrosis.

**Corrosives** are chemicals that may cause visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact. Examples include sulfuric acid, chromic acid, potassium hydroxide, and sodium hydroxide.

**Asphyxiants** have the ability to deprive tissue of oxygen.

**Simple asphyxiants** are inert gases that displace oxygen. Examples include:

- nitrogen
- carbon dioxide
- hydrogen
- nitrous oxide

**Chemical asphyxiants** render the body incapable of utilizing an adequate oxygen supply. They are toxic at very low concentrations (few ppm). Examples include:

- carbon monoxide
- cyanides
- hydrogen sulfide

**Primary anesthetics** have a depressant effect upon the central nervous system, particularly the brain. Examples include:

- halogenated hydrocarbons
- alcohols

**Hepatotoxic agents** cause damage to the liver. Examples include:

- carbon tetrachloride
- Nitrosamines
- tetrachloroethane

**Nephrotoxic agents** cause damage to the kidneys. Examples include:

- halogenated hydrocarbons
- uranium compounds

**Neurotoxic agents** damage the nervous system. The nervous system is especially sensitive to organometallic compounds and certain sulfide compounds. Examples include:

- trialkyl tin compounds
- thallium
- methyl mercury
- carbon disulfide
- organic phosphorus insecticides
- tetraethyl lead
- manganese

**Hematopoietic (blood) system agents** either directly affect blood cells or bone marrow. Examples include:

- nitrites
- benzene
- aniline
- toluidine
- nitrobenzene

**Pulmonary tissue (lungs) agents** can be toxic, through other mean than by immediate irritant action. Fibrotic changes can be caused by free crystalline silica and asbestos. Other dusts can cause a restrictive disease called pneumoconiosis. Examples include:

- coal dust
- cotton dust
- wood dust

A **teratogen** (embryo toxic or fetotoxic agent) is an agent that interferes with normal embryonic development without damage to the mother or lethal effect on the fetus. Effects are not hereditary. Examples include:

- lead

dibromo dichloropropane

A **mutagen** is a chemical agent that may able to react with nucleophilic structures such as DNA. Mutations can occur on the gene level (gene mutations) when, for example, one nucleotide base pair is change to another. Mutations can also occur on the chromosomal level (chromosomal mutations) when the number of chromosomal units or their morphological structure is altered. Examples of mutagens include most radioisotopes, barium permanganate, and methyl isocyanate.

A **sensitizer** causes a substantial proportion of exposed people to develop an allergic reaction in normal tissue after repeated exposure to the chemical. The reaction may be as mild as a rash (contact dermatitis) or as serious as anaphylactic shock. Examples include:

- epoxides
- amines
- toluene diisocyanate
- nickel compounds
- poison ivy
- formaldehyde
- chlorinated hydrocarbons
- chromium compounds

## TARGET ORGAN EFFECTS

The following is a target organ categorization of effects, which may occur from exposure to hazardous chemicals, including examples of signs and symptoms, and chemicals that have been found to cause such effects.

| | SIGNS & SYMPTOMS | EXAMPLES INCLUDE |
|---|---|---|
| **Hepatotoxins (liver)** | jaundice, liver enlargement | carbon tetrachloride, nitrosamines, chloroform, toluene, perchloroethylene, cresol, dimethylsulfate |
| Ne**phrotoxins (kidney)** | edema, proteinuria | halogenated hydrocarbons, uranium, chloroform, mercury, dimethyl sulfate |
| **Neurotoxins (nervous system)** | narcosis, behavioral changes, decreased muscle coordination | mercury, carbon disulfide, benzene, carbon tetrachloride, lead, mercury, nitrobenzene |
| **Hematopoietic (blood) system** | cyanosis, loss of consciousness. | carbon monoxide, cyanides, nitrobenzene, aniline, arsenic, benzene, toluene |
| **Pulmonary (lung) system** | cough, tightness in chest, shortness of breath. | silica asbestos, nitrogen dioxide, ozone, hydrogen sulfide chromium, nickel, alcohol. |
| **Reproductive system (mutations and teratogenesis)** | birth defects sterility. | lead, dibromo dichloropropane. |
| **Skin (dermal layer)** | defatting of skin, rashes, irritation. | ketones, chlorinated compounds, alcohols, nickel, phenol, trichloroethylene. |
| **Eye or vision** | conjunctivitis, corneal damage. | organic solvents, acids, cresol, quinone, hydroquinone, benzyl chloride, butyl alcohol, bases. |

# APPENDIX K: FSU RESPIRATORY PROTECTION PROGRAM

FSU has established the following policy to ensure that employees and students are protected from adverse exposures to respiratory hazards. The University is committed to maintaining engineering controls that provide an indoor atmosphere free of harmful chemical, physical and biological agents. This policy will apply in situations where those controls are not sufficient and other means of respiratory protection are required.

This program, training, recordkeeping will be administered by SHERM.

See the university respirator program and student use of respirator policy

## A. SITUATIONS REQUIRING THE USE OF RESPIRATORS.

Respirators are required in any situation where the potential for exposure to a particular airborne contaminant exceeds occupational exposure limits or a hazard assessment determines one to be necessary.

No employee may be exposed to any air contaminant above the levels established by Occupational Safety and Health Administration (OSHA). Employees shall utilize Safety Data Sheets (SDS) or other credible information sources to ensure compliance. Faculty and Staff may not require that a student or employee use a respirator in situations other than those identified in this policy without prior approval of SHERM, who will provide specific guidance. However, voluntary use dust masks is not discouraged (see "dust mask" section below).

This policy covers only the use of face-mounted respirators. Consult SHERM for information on belt-mounted, self-contained, and remote-source respirators and their use.

The University recognizes the following situations when respirator use is required:

- Air monitoring has identified that respiratory hazards are present.
- A hazard assessment identifies that there is a reasonable expectation that an individual could be exposed to respiratory hazards above Permissible Exposure Limits.
- Employees working in areas where contaminant levels may become unsafe without warning, such as emergency response.
- The SDS or chemical label requires the use of a respirator.
- Areas where there is a significant risk that biological agents become aerosolized.
- Spraying of pesticides in greenhouses.

## B. RESPIRATORY PROTECTION FOR EMPLOYEES.

Before any employee may begin a job that requires respirator use, the following items must be completed successfully (in the order listed below).

1. Evaluation by a licensed physician using either a physical examination or medical questionnaire. A medical evaluation is required for each employee who is required to wear a respirator, regardless of the duration and frequency of respirator use. The medical evaluation must be conducted by a licensed physician and completed before respirator fit testing and initial respirator use. The medical evaluation is to be done during the employee's work day.

   The medical evaluation can be accomplished in either of the following two ways.

a. Medical Questionnaire. In some situations the physician may only need to review a medical questionnaire without needing to conduct a physical examination. OSHA's Respirator Medical Evaluation Questionnaire can be completed by the employee and then reviewed by a physician who determines the employee's fitness to wear a respirator. The physician may request an office visit for a physical examination for any reason if he or she feels it is appropriate. The following information must be submitted to the physician:

- The completed Respirator Medical Evaluation Questionnaire.
- A SDS for the material to which the employee will be exposed.
- A copy of this policy.

b. Physical Medical Examination. The employee visits a physician who will evaluate the employee's physical fitness to wear a respirator. The physician will conduct whatever tests he/she feels are appropriate, but at a minimum will provide information adequate to ensure that the wearer is physically fit to wear the respirator. If the physician is properly equipped, the user seal and fit tests may be conducted at the same time. Upon visiting a physician, the employee must bring the following information:

- A SDS for the material to which the employee will be exposed
- A copy of this policy.
- The specified respirator if user seal and fit test are to be conducted during the physical.

The physician must provide a written opinion of the individual's fitness to wear a respirator and whether or not there are any conditions employee or employer must follow. One copy of the approval shall be placed in the employee's file, and one copy provided to the employee.

The evaluation is required only once, except under the following circumstances:

c. Physician recommends re-evaluation at a specific interval.
d. Changes in the workplace that may result in an increase on the physical burden of the employee or significantly increase exposure.
e. The employee reports suffering distress through wearing a respirator, signs or symptoms relating to respirator use, or a change in health condition that may affect respirator use.
f. The University determines it is necessary.

The evaluations must be conducted by Birkham Health Center. Prior arrangements need to be made by a supervisor.

Upon termination of employment, medical evaluations shall be permanently kept in the employee's medical file.

2. Training in Respirator Use. All employees required to wear respirators will be trained in the hazards present and proper selection, fit testing, use, and maintenance of respirators. This will be done both before an employee begins the use of a respirator and annually thereafter. All employees will be made aware of the hazards present from all chemicals as part of the University's hazard communication or Lab Safety Program.

3. Checking Fit Prior to Use. Employees must ensure the respirator provides a proper fit. Fit testing can only be performed after the physician has given approval for the employee's respirator use. Also, fit testing and respirator use in general cannot be done if there is facial hair between the skin and the facepiece of the respirator. Proper fit is to be checked as follows:

(a) User Seal Check Procedure. Each time an employee uses a respirator, proper fit must be checked (see OSHA User Seal Check Procedures). This is done using either of the following two procedures.

- Positive Pressure Facefit Check. To check, place palm of hand over the exhalation valve cover and exhale gently. Be careful not to disturb the position of the respirator. If the facepiece bulges slightly, and no air leaks between the face and the facepiece are detected, a proper fit has been obtained. If air leakage is detected, reposition the respirator on the face and/or readjust the tension of the elastic straps to eliminate the leakage. Repeat the above steps until a tight seal is obtained. If a proper fit cannot be achieved, the employee may not enter the area but should instead see his/her supervisor.
- Negative Pressure Facefit Check. To check, place the palms of hands or thumbs over both filters. Be careful not to disturb the position of the respirator. The employee should then inhale gently and hold his/her breath for five to ten seconds. If the facepiece collapses slightly, a proper fit has been obtained. If air leakage is detected, reposition the respirator on the face and/or readjust the tension of the elastic straps to eliminate the leakage. Repeat the above steps until a tight seal is obtained. If proper fit cannot be achieved, the employee cannot enter the area but should instead see his/her supervisor.

(b) Fit Testing. These tests are conducted by SHERM after the employee has passed the medical exam and user seal check. These tests are to be performed at least annually, and under the following circumstances: a new respirator is purchased, the employee requests a test, a request by a supervisor, doctor, or the University, and any other condition that may lead to a poor seal of a respirator.

## *C.* **RESPIRATOR STORAGE AND MAINTENANCE**.

Respirators must be stored inside a cabinet or drawer with a door to keep out dust, sunlight, extreme heat or cold, moisture, or chemicals. Respirators should be stored so facepieces and exhalation valves will rest in a normal position to prevent rubber or plastic from reforming into an abnormal shape.

The respirator body shall be replaced whenever found to be faulty (i.e. cracked or broken face seal or body). A valve or headband shall be replaced as soon as any performance loss is noticed.

Each employee is responsible for keeping his/her respirator clean and in good condition, and returning it to the respirator cabinet in a sealed bag, which is usually provided with a new respirator. Avoid sealing wet respirators in airtight bags due to potential for mold growth. Respirators must be cleaned and disinfected regularly using antiseptic wipes or soap and water. If employees must share a respirator, it must be disinfected after each use.

1. Respirators. Respirators will be issued to each person required to wear a respirator. The University will provide the respirator and cartridges at no cost to the employee. Each respirator will be clearly marked with the person's name to prevent the sharing or exchanging of respirators.

2. Inspection of the Effectiveness of the Respirator Program. The supervisors are responsible for making regular checks of work area conditions and employee practices to make sure the respirator program is effective. Inspections will ensure that proper respirators and cartridges are used, respirators are used at appropriate times, and that they are clean, clearly labeled and well maintained.

3. Temporary Changes in Conditions. If air sampling reveals unusually high levels of any potentially harmful material, this respirator policy may be temporarily modified by SHERM.

D. **RESPIRATORS AND CARTRIDGES**.

The following respirators have been approved by the SHERM.

| | 3M 6000 SERIES |
|---|---|
| Respirator Body – Small, Medium or Large | 6100, 6200 or 6300 |
| Full Facepiece Respirator (S-L) | 6700-6900 |
| P-100 HEPA Filter | magenta |
| P-100 HEPA Organic Vapor / Acid Gas Filter | yellow/magenta |

1. Filters. Always consult the product Safety Data Sheet and the cartridge manufacturer to ensure proper cartridge selection prior to use. NO FILTER WILL PROVIDE PROTECTION IN OXYGEN DEFICIENT ATMOSPHERES. There are two main types of filters that will typically be used:

(a) P-100 HEPA Filter. The first is a HEPA (High Efficiency Particulate) filter. This filter removes airborne particulates and aerosol contaminants such as silica, sawdust, most biological contaminants, or liquid particles (non-oil) that do not emit harmful vapors. A respirator fitted with this filter will provide protection from dusts, fumes, or mists by capturing course and fine particles on the filter.

HEPA filters have served their useful life and must be replaced when visibly dirty, when breathing resistance becomes excessive, or when the user experiences taste, smell or irritation related to the particles being filtered.

(b) P-100 HEPA Organic Vapor/Acid Gas Filter. This type of filter cartridge protects against certain organic vapors, acid gas and particulates that may be found in laboratories, pharmaceutical and chemical manufacturing. When properly fitted these provide respiratory protection from certain organic vapors, chlorine, hydrogen chloride, sulfur dioxide, or hydrogen sulfide or hydrogen fluoride and particulates at concentrations up to 10 times the Permissible Exposure Limit. Not to be used for formaldehyde, ammonia, mercury vapor or methylamine.

Follow the manufacturer's recommendations for use and replacement recommendations. In general, if the user experiences taste, smell or irritation related to the chemical being used the filter should be replaced.

E. **DUST MASKS**.

1. Required Use of Dust Masks. In no case does a dust mask provide adequate protection against inhalation of airborne contaminants above occupational exposure levels. Typical respiratory hazards at the University do not require the use of dust masks; however any employee can request to wear a dust mask for his/her own comfort. The University will keep a supply of NIOSH-approved dust masks and provide them at no expense to the employee.

If an employee is required to wear a dust mask, the requirements stated in this policy for employee respiratory protection must be followed. That includes medical evaluation and training, but not fit testing requirements.

2. Voluntary Use of Dust Masks. If a supervisor chooses to allow employees to wear dust masks voluntarily, they must do the following:

   a. Ensure that the dust mask will not itself create a safety or health hazard to the individual wearing it.
   b. Provide the individual with the information provided in OSHA's Information for Employees Using Respirators When Not Required.

F. **INDOOR AIR MONITORING**.

The University will conduct representative sampling when there is reason to believe that an employee may be exposed to airborne contaminants above OSHA's Permissible Exposure Limits (PEL) or action levels during a typical work day. All sampling and monitoring shall be coordinated through SHERM. Individuals who are sampled will receive written results of their sampling within two weeks of receipt of the report from the laboratory.

1. Monitoring will be conducted at the following intervals:

   c. Initial Monitoring. When an area begins or significantly alters the use of a chemical suspected to exceed the OSHA PEL or Action Level, a sample from all job classifications with potential exposure above the Action Level will be taken. Additionally, any significant changes in production, process, handling procedures, etc. that might increase the level of contaminants in the atmosphere makes retesting necessary.
   d. Routine Monitoring. At appropriate intervals, routine monitoring may be performed to ensure the levels are within the acceptable limits. All job classifications that are required to wear a respirator and some that could have potential exposure will be sampled. If results above the Action Level are detected, sampling will be done every six months until operational changes bring levels within acceptable limits.
   e. Complaint Monitoring. If there are reports of signs or symptoms that may indicate overexposure, such as respiratory or skin conditions associated with exposure to airborne contaminants, the affected individuals must notify their supervisor immediately. SHERM will determine whether monitoring will be necessary.

2. Working Areas. The University will maintain the general working area with exposures well below the PEL. If any areas exceed that level, the appropriate respiratory protection must be worn until corrective engineering controls are implemented. These would usually include operational changes, improved ventilation, or facility improvements.

   If a particular area is expected to be above the PEL, all entrances must be posted with an appropriate warning sign.

3. Exposure Levels.

   Consult the SDS for exposure levels of airborne contaminants.

   (a) Action Level. An eight hour time weighted average concentration below which no further action is needed.

(b) PEL. The maximum eight hour time weighted average concentration that an employee can be exposed to without wearing a respirator. Monitoring results between the Action Level and PEL will be resampled within six months of the sampling event. If monitoring results show exposure above the PEL, full-time respirator use will be required for that job until satisfactory results are received. This requirement will be waived only if there is compelling evidence that the test was not representative of the employee's exposure.

(c) STEL. The maximum concentration of airborne contaminants that an employee can be exposed to in a 15 minute period. Job classifications where employee exposure may exceed the STEL require respirator use while performing these jobs.

(d) Maximum Concentration. The level above which special types of respirators must be used. Areas exceeding the Maximum Concentration must improve their engineering controls to reduce these levels.

4. Recordkeeping. The University must maintain any records concerning employee exposure, monitoring, and training at their facility. Corporate will keep the following records for the necessary retention time:

| Records | Retention Time |
|---|---|
| Exposure monitoring results | 30 years |
| Training | 30 years (file with exposure results) |
| Medical Surveillance | Duration of employment plus 30 years. |
| Respirator Fit Test | Until replaced by a more recent record. |

# APPENDIX L: VOLUNTEERS IN LABS TEMPLATE

Date:

Volunteer Name:
Address:
City/State/Zip:

**RE: Ferris State University ("University") Lab Volunteer**

Dear Volunteer:

Thank you for your interest in volunteering to assist in the _____laboratory under the direction of _____.

The University is obligated to provide a safe working environment for volunteers, adhering to the same standards it has for its employees. Before you can begin your volunteer assignment you will be required to complete appropriate lab safety training.

Your roles and responsibilities as a laboratory volunteer are as follows:

_____

With regard to general liability, the University Board of Trustees indemnifies properly appointed volunteers the same as a University employee pursuant to the requirements and conditions outlined in Business Policy Letter: *Legal Representation and Indemnification*.

Please consider the aforementioned expectations and complete the *Laboratory Volunteer Profile, Disclosure, Consent, Assumption of Risk, Release and Waiver of Liability, and Covenant not to Sue Form* with the required information and return the signed copy to me. Upon receipt, we can schedule you for lab safety training, provide you with a schedule, and provide a date for you to begin your volunteer assignment.

Again, I want to thank you for volunteering your time to the University and supporting its important mission in educating and shaping the lives of our students.

Sincerely,

FSU Laboratory Volunteer Profile, Disclosure, Consent, Assumption of Risk, Release and Waiver of Liability, and Covenant not to Sue Form **("Form")**
(Department to keep on file)

**Volunteer Name:** (please print): _____ ("Volunteer")
Over Age 18: Yes____ No____

Address: _____City: _____State: ___ Zip Code: _____

Telephone (include area code): _____ Cell Phone: _____Email: _____

**Emergency Information**:

Contact Name: _____ Telephone (include area code): _____

Email (if known): _____Relationship to Volunteer: _____

Thank you for volunteering your time and talent to Ferris State University ("University") in support of its important mission of educating and shaping the lives of our students.

A University volunteer is an individual who performs work or provides services in support of University activities without the expectation of compensation. Volunteers may perform a variety of services, however the University does not intend for volunteers to perform or displace work that is presently being performed by University employees.

Volunteers acting on behalf of the University are expected to adhere to University policies, including, but not limited to, those policies concerning laboratory safety, alcohol and drug use, vehicle use, personal conduct, fiscal propriety, sexual harassment, diversity, and non-discrimination. The University may, as a result of inappropriate conduct or other valid reasons, remove volunteers from a University laboratory.

Volunteers are not considered employees and are not covered by workers' compensation disability benefits. Therefore volunteers are personally responsible for the expense of any medical care received for injuries incurred because of volunteer service to the University. Volunteers are not eligible for unemployment benefits.

The University may require you to complete and pass a criminal background check before your volunteer assignment begins.

## Disclosure of Associated Risks

The University endeavors to provide a safe working environment for volunteers, adhering to the same standards it has for its employees. Therefore, there are dangers and risks to which you may be exposed as a volunteer in a University laboratory. These dangers and risks may include, but are not limited to, the possibility of slight or severe bodily injury, or death, hazardous substances (chemicals/biologicals, etc.), physical hazards (very hot or cold temperatures, laser light, electromagnetic frequencies), and: _____
_____
_____
_____ ("dangers and risks").

I, the undersigned, am aware of the dangers and risks directly or inherently involved in volunteering in a University laboratory. I voluntarily agree to assume all responsibility and risk of injury to myself or my property arising from, but not limited to, my volunteering in a University laboratory and related activities including all dangers and risks of accidents, illness, bodily injury, and property damage.

I, individually and on behalf of my heirs, successors, assigns, and personal representatives, hereby covenant not to sue and release and waive the University, its trustees, employees, agents, officers, and representatives ("Releasees") from any and all liability, claims, and actions I may have for damages, losses or injuries I may sustain to my person or property arising out of my volunteering in a University laboratory, except if damage, loss, or injury is directly caused by the gross negligence or willful wanton misconduct of the Releasees.

**I HAVE CAREFULLY READ THIS ENTIRE FORM. I FULLY UNDERSTAND THE FORM AND ITS PROVISIONS, AND AGREE TO BE BOUND BY ITS TERMS AND CONDITIONS. I INTEND FOR THIS FORM TO BE VALID AND BINDING.**

_____ _____
Signature of Volunteer Date

_____
Name (Please Print)

If the above signed is not of legal age (18) at the date of signing, this form must be signed by the Volunteer's parent or legal guardian.

As the parent or legal guardian of the Volunteer whose signature appears above, I have read and understand the conditions outlined above, have given my child or ward permission to become a volunteer, and agree to be bound by the conditions outlined above as if I myself had signed above.

_____ _____
Signature of Parent/Legal Guardian Date

_____
Name (Please Print)

****NOTE TO DEPARTMENTS****
*Signed originals should be retained by the Department for a period of one-year post completion of the volunteer assignment.*

Approved – FSU General Counsel – 1/16/2020

# APPENDIX M: LIST OF 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.

**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 death or unconsciousness 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.

**Autoclave --** A device to expose items to steam at a high pressure in order to decontaminate the materials or render them sterile.

**Biohazard --** Infectious agents that present a risk or potential risk to the health of humans or other animals, either directly through infection or indirectly through damage to the environment.

**Boiling Point --** The temperature at which the vapor pressure of a liquid equals atmospheric pressure or at which the liquid changes to a vapor. The boiling point is usually expressed in degrees Fahrenheit. If a flammable material has a low boiling point, it indicates a special fire hazard.

"**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).

**Carcinogen --** A substance that may cause cancer in animals or humans.

**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 --** An employee who is designated by the employee 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 --** 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 (37.8deg.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 --** A gas or mixture of gases that, in a container, will have an absolute pressure exceeding 40 psi at 70°F or 21.1°C. A gas or mixture of gases having, in a container, an absolute pressure exceeding104 psi at 130°F or 54.4°C, regardless of the pressure at70°F. A liquid having a vapor pressure exceeding 40 psi at 100°For 37.8°C.

**Concentration --** The relative amount of a material in combination with another material. For example, 5 parts (of acetone) per million (parts of air).

**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.

**Cutaneous/Dermal** -- Pertaining to or affecting the skin.

**Cytotoxin** -- A substance toxic to cells in culture, or to cells in an organism.

**Decomposition** -- The breakdown of a chemical or substance into different parts or simpler compounds. Decomposition can occur due to heat, chemical reaction, decay, etc.

**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.

**Dermatitis** -- An inflammation of the skin.

**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.

**EPA** -- The Environmental Protection Agency is the governmental agency responsible for administration of laws to control and/or reduce pollution of air, water, and land systems.

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

**Epidemiology** -- The study of disease in human populations.

**Erythema** -- A reddening of the skin.

**Evaporation Rate** -- The rate at which a material is converted to vapor (evaporates) at a given temperature and pressure when compared to the evaporation rate of a given substance. Health and fire hazard evaluations of materials involve consideration of evaporation rates as one aspect of the evaluation.

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

**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 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 LOCALEXHAUST VENTILATION).

**Grams per Kilogram (g/Kg)** -- This indicates the dose of a substance given to test animals in toxicity studies. For example, a dose may be 2 grams (of substance) per kilogram of body weight (of the experimental animal).

**Hazardous Chemicals** -- Any chemical 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.

**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.

**Ingestion** -- Taking a substance into the body through the mouth as food, drink, medicine, or unknowingly as on contaminated hands or cigarettes, etc.

**Inhalation** -- The breathing in of an airborne substance that may be in the form of gas, fumes mists, vapors, dusts, or aerosols.

**Inhibitor** -- A substance that is added to another to prevent or slowdown an unwanted reaction or change.

**Irritant** -- A substance that produces an irritation effect when it contacts skin, eyes, nose, or respiratory system.

**Laboratory** -- A facility where relatively small quantities of hazardous materials are used on a non-production basis.

**Laboratory Scale** -- Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person.

**Laboratory-type Hood** -- A device constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory.

**Laboratory Use of Hazardous Materials** -- The handling or use of chemicals in which the following conditions are met: (1) Chemical manipulations are carried out on a laboratory scale. (2) Multiple chemical procedures or chemicals are used. (3) The procedures involved are not part of a production process. (4) Protective laboratory practices and equipment are available and in common use to minimize the potential for personnel exposure to hazardous chemicals.

**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.

**Lethal Concentration$_{50}$** -- The concentration of an air contaminant **($LC_{50}$)** that will kill 50 percent of the test animals in a group during a single exposure.

**Lethal Dose$_{50}$** -- The dose of a substance or chemical that will **($LD_{50}$)** kill 50 percent of the test animals in a group within the first30 days following exposure.

**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).

**Melting Point** -- The temperature at which a solid changes to a liquid. A melting range any be given for mixtures.

**Mutagen** -- Anything that can cause a change (or mutation) in the genetic material of a living cell.

**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.

**NIOSH** -- The National Institute for Occupational Safety and Health is a 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.

**Oxidation** -- The process of combining oxygen with some other substance or a chemical change in which and atom loses electrons.

**Oxidizer** -- Is a substance that gives up oxygen easily to stimulate combustion of organic material.

**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.

**Polymerization** -- A chemical reaction in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecules. A hazardous polymerization is the above reaction with an uncontrolled release of energy.

**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 a SDS.

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

**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** 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 $10mg/ml^3$
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

**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 particular 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.

**Systemic** -- Spread throughout the body; affecting many or all body systems or organs; not localized in one spot or area.

**Teratogen** -- An agent or substance that may cause physical defects in the developing embryo or fetus when a pregnant female is exposed to that substance.

**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 period. Represented as TLV-TWA.

**Toxicity --** The potential of a substance to exert a harmful effect on humans or animals and a description of the effect and the conditions or concentration under which the effect takes place.

**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.

**Vapor Pressure --** The pressure that a solid or liquid exerts when it is in equilibrium with its vapor at a given temperature.

**Water-reactive --** A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.