



# **CHEMICAL HYGIENE PLAN**

**Adopted: February 2014**  
**Revised: February 21, 2016**

**PURDUE UNIVERSITY**  
**Chemical Hygiene Plan**

**Lab-Specific Plan**

**This is the Chemical Hygiene Plan (CHP) specific to the following areas:**

Building(s): Drug Discovery Research Facility

Room Number(s): DRUG 210,210A, 201B, 274, 274B

Principal Investigator (Lab Supervisor): Gaurav Chopra

Department: Chemistry

Revised (*Must be reviewed at least annually.*): 2/1/2016

**Important Telephone Numbers:**

1. 911 for All Emergencies
2. (765) 494-8221 Purdue Police Department (Non-Emergency Line)
3. (765) 494-6919 Purdue Fire Department (Non-Emergency Line)
4. (765) 494-6371 Purdue REM (Do Not Use for an Emergency)

*Laboratories engaged in the laboratory use of hazardous chemicals must maintain a lab-specific Chemical Hygiene Plan (CHP) which conforms to the requirements of 29 CFR 1910.1450, the Occupational Safety and Health Administration (OSHA) Occupational Exposure to Hazardous Chemicals in Laboratories Standard (Lab Standard). Purdue University laboratories may use this document as a starting point for creating their lab-specific CHP. At a minimum, this cover page must be edited for location specificity (laboratories on campuses other than West Lafayette must replace emergency, fire, and police telephone numbers with those used at their specific campus or location). In addition, all lab employees must complete a Lab-Specific Training Certification form. This instruction and information box should remain. This model Chemical Hygiene Plan is the 2014 version; the most current version can also be found on the Radiological and Environmental Management website Forms page.*

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## CHP Document Abbreviations List

|             |  |
|-------------|--|
| <b>ANSI</b> | American National Standards Institute                                  |
| <b>ASTM</b> | American Society of Testing and Materials                              |
| <b>CFR</b>  | Code of Federal Regulations  |
| <b>CHO</b>  | Chemical Hygiene Officer   |
| <b>CHP</b>  | Chemical Hygiene Plan  |
| <b>CLSC</b> | Chemical and Laboratory Safety Committee                               |
| <b>DOT</b>  | Department of Transportation   |
| <b>EHS</b>  | Environmental Health and Safety  |
| <b>EPA</b>  | Environmental Protection Agency  |
| <b>GFCI</b> | Ground Fault Circuit Interrupter                                       |
| <b>GHS</b>  | Globally Harmonized System of Classification and Labeling of Chemicals |
| <b>HBr</b>  | Hydrogen Bromide   |
| <b>HF</b>   | Hydrofluoric Acid  |
| <b>HEPA</b> | High-Efficiency Particulate Air  |
| <b>HPLC</b> | High Performance Liquid Chromatography                                 |
| <b>IBC</b>  | Institutional Biosafety Committee                                      |
| <b>IDEM</b> | Indiana Department of Environmental Management                         |
| <b>ISP</b>  | Integrated Safety Plan   |
| <b>LC</b>   | Liquid Chromatography  |
| <b>LC50</b> | Lethal Concentration 50%   |
| <b>LD50</b> | Lethal Dose 50%  |
| <b>LEL</b>  | Lower Explosive Limit  |
| <b>LSC</b>  | Laser Safety Committee   |
| <b>MSDS</b> | Material Safety Data Sheet   |
| <b>NFPA</b> | National Fire Protection Association                                   |
| <b>OSHA</b> | Occupational Safety and Health Administration                          |
| <b>PCB</b>  | Polychlorinated Biphenyl   |
| <b>PHS</b>  | Particularly Hazardous Substance                                       |
| <b>PI</b>   | Principal Investigator   |
| <b>PPE</b>  | Personal Protective Equipment  |
| <b>RCRA</b> | Resource Conservation and Recovery Act                                 |
| <b>rDNA</b> | Recombinant Deoxyribonucleic Acid                                      |
| <b>REM</b>  | Radiological and Environmental Management                              |
| <b>RSC</b>  | Radiation Safety Committee   |
| <b>SAA</b>  | Satellite Accumulation Area  |
| <b>SDS</b>  | Safety Data Sheet  |
| <b>SOP</b>  | Standard Operating Procedure   |
| <b>UEL</b>  | Upper Explosive limit  |

# Chapter 1: Introduction

Laboratory safety is an integral part of laboratory research and is essential to ensure that Purdue University's compliance with all applicable environmental, health and safety laws, regulations and requirements are met. The risks associated with laboratory research (workplace injuries, environmental incidents, and property losses or damage) are greatly reduced or eliminated when proper precautions and practices are observed in the laboratory. To better manage and mitigate these risks, the Purdue University Radiological and Environmental Management Department (REM) has developed the Chemical Hygiene Plan (CHP), which is intended to be the cornerstone of your laboratory safety program and is designed to aid faculty, staff, and students in maintaining a safe environment in which to teach and conduct research. Each laboratory using hazardous materials is required to have a copy of the CHP readily available to all laboratory personnel. Each laboratory worker must be familiar with the contents of the CHP and the procedures for obtaining additional safety information needed to perform their duties safely.

## 1.1 Purpose

Purdue University is committed to providing a healthy and safe work environment for the campus community. The Purdue University CHP establishes a formal written program for protecting laboratory personnel against health and safety hazards associated with exposure to hazardous chemicals and must be made available to all employees working with hazardous chemicals in a laboratory setting. The CHP describes the proper use and handling procedures to be followed by faculty, staff, and all other personnel working with hazardous chemicals in laboratory settings.

## 1.2 Scope

The CHP applies to all laboratories that use, store, or handle hazardous chemicals and all personnel who work in these facilities. The information presented in the CHP represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize hazardous chemicals. Laboratory use of hazardous chemicals is defined as handling or use of such chemicals in which all of the following conditions are met:

1. Chemical manipulations are carried out on a laboratory scale;
2. Multiple chemical procedures or chemicals are used;
3. The procedures involved are not part of a production process, nor in any way simulate a production process; and



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

The CHP was prepared in accordance with the requirements of the Occupational Safety and Health Administration (OSHA) Occupational Exposure to Hazardous Chemicals in Laboratories Standard (Lab Standard) found in 29 CFR 1910.1450, and is based on best practices identified in, among other sources, the “Global Harmonized System of Classification and Labeling of Chemicals”; “Prudent Practices for Handling Hazardous Chemicals in Laboratories”, published by the National Research Council, the American Chemistry Society Task Force on Laboratory Chemical and Waste Management’s “Laboratory Waste Management, A Guidebook”; the Princeton University “Laboratory Safety Manual”; and the University of California – Los Angeles “Chemical Hygiene Plan”.

### 1.3 CHP Use Instructions

The information presented in the CHP represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize hazardous chemicals. It is not intended to be all inclusive. Departments engaged in work with hazardous chemicals or hazardous operations that are not sufficiently covered by the CHP must customize this document by adding appropriate sections, in the form of standard operating procedures (SOPs), hazard assessments, and any other written (or referenced) lab-specific operating procedures or protocols that address the hazards and how to mitigate risks. The following instructions detail how this CHP template should be used and customized by each laboratory:

- Review this template CHP provided by REM.
- Insert your lab-specific standard operating procedures (SOPs) into your customized CHP under Tab 1 located in the back of the CHP document. More details regarding SOPs can be found in Chapter 4 of the CHP.
- Insert all other documented lab-specific rules, requirements, and procedures (e.g., equipment protocols, chemical experiment protocols, internal lab inspections or rules, etc.,) under Tab 2.
- Insert your lab-specific hazard assessments under Tab 3. More details regarding hazard assessments can be found in Chapter 6 of the CHP.
- Once each lab employee has reviewed and is familiar with the contents of the lab-specific CHP, document the training using the CHP Training Certification Form found in Appendix A of the CHP. See Chapter 9 for additional detail regarding CHP training.
- Review, update (if necessary), and retrain all employees on the lab-specific CHP at least annually and document this training.

## 1.4 Employee Rights and Responsibilities

As part of the OSHA Laboratory Standard, employees and other personnel who work in laboratories have the right to be informed about the potential hazards of the chemicals in their work areas and to be properly trained to work safely with these substances. This includes custodial and maintenance personnel (support staff) who work to maintain laboratories. All personnel, including principal investigators, laboratory supervisors, laboratory technicians, student workers, and support staff have a responsibility to maintain a safe work environment. All personnel working with chemicals are responsible for staying informed on the chemicals in their work areas, safe work practices and SOPs, and proper personal protective equipment (PPE) required for the safe performance of their laboratory work.

### 1.4.1 Laboratory Supervisor Responsibilities

The Laboratory Supervisor is the individual that is ultimately responsible for the overall laboratory operation, including the lab safety program and ensuring that the requirements of the CHP are followed by all staff members that work in the lab. For most research laboratories, the Principal Investigator (PI) is the Laboratory Supervisor. In cases where the PI has hired an individual such as a lab manager or postdoctoral scholar to manage the daily operations of the lab, the PI is still ultimately responsible for the overall operation of the lab and is considered to be the Laboratory Supervisor. The Laboratory Supervisor may delegate some safety duties to a qualified individual, but ultimately remains responsible for the safety of all personnel working in the laboratory. Specifically, the Laboratory Supervisor must:

- Understand applicable environmental health and safety rules, including the contents of the CHP;
- Identify hazardous conditions or operations in the laboratory and establish SOPs and hazard assessments to effectively control or reduce hazards;
- Ensure that all laboratory personnel that work with hazardous chemicals receive appropriate training (refer to Chapter 9 for detailed training requirements);
- Maintain written records of lab-specific training (e.g., PPE training);
- Ensure that appropriate PPE (e.g., laboratory coats, gloves, eye protection, etc.,) and engineering control equipment (e.g., chemical fume hood) are made available, in good working order, and being used properly;
- Conduct periodic lab inspections and immediately take steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards; and

- Actively enforce all applicable safety procedures and ensure that the CHP is followed by lab staff and all visitors, including having a progressive disciplinary process for lab staff members that do not comply with safety rules.

Laboratory Supervisors must ensure that employees receive CHP training and information before any work with hazardous materials occurs. Laboratory Supervisors must also ensure that all employees receive annual CHP refresher training. The Laboratory Supervisor can provide the training or delegate this task to a qualified individual (e.g., Laboratory Safety Officer, senior lab employee). The CHP training must be documented. See Appendix A for the CHP Lab-Specific Training Certification form, which can be used to document reading the CHP. Failure to follow the requirements of the CHP could possibly result in injuries, fines from regulatory agencies such as OSHA, and/or disciplinary action.

#### **1.4.2 Laboratory Employee Responsibilities**

All employees (e.g., graduate research assistants, graduate students, undergraduate students, lab technicians, post-doctoral researchers, and visiting scientists) in laboratories that use, handle, or store hazardous chemicals must:

1. Review and follow the requirements of the CHP;
2. Follow all verbal and written laboratory safety rules, regulations, and SOPs required for the tasks assigned;
3. Develop and practice good personal chemical hygiene habits such keeping work areas clean and uncluttered;
4. Plan, review, and understand the hazards of materials and processes in the laboratory prior to conducting work;
5. Utilize appropriate measures to control hazards, including consistent and proper use of engineering controls, administrative controls, and PPE;
6. Understand the capabilities and limitations of PPE;
7. Immediately report all accidents, near misses, and unsafe conditions to the Laboratory Supervisor;
8. Complete all required REM and/or other mandatory safety training and provide written documentation to the Laboratory Supervisor;
9. Participate in the REM managed medical surveillance program when required; and
10. Inform the Laboratory Supervisor of any work modifications ordered by a physician as a result of medical surveillance, occupational injury, or chemical exposure.

### 1.4.3 Laboratory Safety Officer Responsibilities

Very often it is not practical for the Laboratory Supervisor to be present in the lab on a daily basis to ensure that safe and compliant practices are being carried out by all lab staff. For this reason, it is highly recommended that each Laboratory Supervisor establish a Laboratory Safety Officer to manage the daily operations of the lab's safety program. The Laboratory Supervisor should empower the Laboratory Safety Officer to make decisions on daily operations involving safety and compliance, including the authority to instruct other lab personnel to follow all safety procedures (e.g., PPE use, hazardous waste procedures, etc.). This person should be familiar with how the lab operates and have demonstrated lab safety experience (e.g., senior graduate student, post-doc, lab manager). Having a Laboratory Safety Officer in the lab provides many benefits such as:

- Other lab personnel know who to contact with questions about daily operations involving safety and compliance;
- Empowers someone other than the Laboratory Supervisor to enforce lab safety rules;
- Provides consistency within the respective academic department; idea is that each Laboratory Safety Officer attends departmental safety committee meetings and reports issues back to the lab; and
- Provides good, marketable experience for the Laboratory Safety Officer to be involved in a safety leadership role.

The role of the Laboratory Safety Officer should include:

1. Provide appropriate training to new lab personnel and ensure that the training is properly documented;
2. Enforce lab safety rules;
3. Attend departmental/college level safety committee meetings and report significant information back to the lab; and
4. Report safety issues back to the Laboratory Supervisor when necessary.

### 1.4.4 Non-Laboratory Personnel / Support Staff Responsibilities

Custodians and maintenance staff (support staff) often must enter laboratories to perform routine tasks such as cleaning and equipment maintenance. Support staff members are expected to follow the posted safety rules of each laboratory. Minimum PPE requirements for support staff working in a laboratory are safety glasses, long pants, and closed-toe shoes. If additional PPE is required or if other unique safety requirements must be followed,

it is the lab personnel's responsibility to notify support staff. These additional requirements should be clearly communicated to support staff; posting the requirements on the lab door or somewhere else highly visible is recommended.

#### **1.4.5 Chemical Hygiene Officer Responsibilities**

The Chemical Hygiene Officer, who is the Director of REM, or designated individual(s), has the primary responsibility for ensuring the implementation of all components of the CHP. The Chemical Hygiene Officer must:

- Inform Laboratory Supervisors of all health and safety requirements and assist with the selection of appropriate safety controls (engineering controls, administrative controls, and PPE);
- Ensure that Laboratory Supervisors have the necessary resources to maintain compliance with the CHP and that all lab staff receive appropriate training;
- Act as the liaison between the Laboratory Supervisors and the Purdue Chemical Laboratory Safety Committee;
- Conduct periodic lab inspections and immediately take steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
- Ensure that SOPs and hazard assessments are being prepared;
- Maintain employee exposure-monitoring records, when applicable;
- Help to develop and implement appropriate environmental health and safety policies and procedures;
- Review and evaluate the effectiveness of the CHP program at least annually and update it as appropriate; and
- Actively enforce all applicable safety procedures and ensure the contents of the CHP are followed; take appropriate actions when safety procedures are not followed.

### **1.5 Radiological and Environmental Management Department**

The Radiological and Environmental Management Department (REM) serves as the environmental health and safety department for Purdue University. REM's primary role is to manage regulatory compliance with all federal, state, and Purdue regulations involving environmental health and safety issues. REM facilitates a number of programs that apply to laboratory safety, a few of which include biological safety, laser safety, personal protective equipment, radiation safety, development of standard operating procedures, as well as the CHP. REM also performs numerous safety inspections of facilities throughout the year to monitor compliance with regulatory requirements. REM also provides a variety of services such

as chemical, biological, and radioactive waste pickups, and safety training and consultation. More detailed information regarding all of REM's resources and services can be found on the REM website. (<http://www.purdue.edu/ehps/rem/>)

## 1.6 Integrated Safety Plan

It is the policy of Purdue University to integrate environmental health and safety into all operations. The Integrated Safety Plan (ISP), which is facilitated by REM, was developed to provide a framework for laboratories to comply with environmental health and safety (EHS) regulations. The ISP assists in communication of EHS issues across the organization and calls for departmental level safety committees and individual self-audits. The ISP provides indemnification from regulatory fines for units with a certified safety program. An ISP certified safety program must have the following elements:

- Regular safety committee meetings;
- Means of communicating safety issues to the department in a timely manner;
- Upper administrative support for safety;
- Self-audits checklists, which is a self-inspection program, must be completed for all areas;
- Abatement of deficiencies found during the self-audits;
- An annual safety program audit and walk-through by REM; and
- Recommendation for ISP certification renewal from REM

More information about the ISP program can be found on the REM website (<http://www.purdue.edu/ehps/rem/home/ispinfo.htm>).

## 1.7 Chemical and Laboratory Safety Committee

Purdue University has established the Chemical and Laboratory Safety Committee (CLSC) with the responsibility to promote safe and proper chemical management at all Purdue University Campuses and related facilities. Chemical management includes, but is not limited to, the procurement and the safe handling, use, storage, and disposal of chemicals. The CLSC reviews lab safety programs and makes recommendations to the Provost as appropriate. The CLSC consists of members appointed from the faculty and staff of the major research, teaching, and service areas where chemicals are handled or used. Although REM facilitates the content of the CHP, it is ultimately the responsibility of the CLSC to approve changes and updates to the CHP.

## Chapter 2: Hazardous Chemical Classification Systems

Chemical classification systems are designed to communicate hazards. The three most widely used classification systems are the OSHA Globally Harmonized System for Classifying and Labeling Chemicals (implemented under the OSHA Hazard Communication Standard), the National Fire Protection Association (NFPA) system of classifying the severity of hazards, and the Department of Transportation (DOT) hazard classes. These classification systems are used by chemical manufacturers when creating safety data sheets and chemical labels, therefore it is important that Purdue lab employees understand the basic elements of each classification system.

### 2.1 Globally Harmonized System for Classifying Chemicals

The Globally Harmonized System (GHS) is a world-wide system adopted by OSHA for standardizing and harmonizing the classification and labeling of chemicals. The objectives of the GHS are to:

- Define health, physical, and environmental hazards of chemicals;
- Create classification processes that use available data on chemicals for comparison with the defined hazard criteria (numerical hazard classification is based on a 1 – 5 scale, 1 being the most hazardous and 5 being the least hazardous); and
- Communicate hazard information, as well as protective measures, on labels and Safety Data Sheet (SDS), formerly known as Material Safety Data Sheets (MSDS).

#### 2.1.1 Safety Data Sheets

The SDS provides comprehensive information that is imperative for the safe handling of hazardous chemicals. Laboratory personnel should use the SDS as a resource to obtain information about hazards and safety precautions. SDSs cannot provide information for hazards in all circumstances. However, the SDS information enables the employer to develop an active program of worker protection measures such as training on hazard mitigation. Chemical manufacturers are required to use a standard format when developing SDSs. The SDS will contain 16 headings which are illustrated in Figure 2.1.

|    |  |     |                                  |
|----|--|-----|----------------------------------|
| 1. | Identification of the substance or mixture and of supplier | 9.  | Physical and chemical properties |
| 2. | Hazards Identification                                     | 10. | Stability and reactivity         |
| 3. | Composition/information on ingredients                     | 11. | Toxicological information        |
| 4. | First aid measures   | 12. | Ecological information           |
| 5. | Firefighting measures                                      | 13. | Disposal considerations          |
| 6. | Accidental release measures                                | 14. | Transport considerations         |
| 7. | Handling and storage                                       | 15. | Regulatory information           |
| 8. | Exposure controls/personal protection                      | 16. | Other information                |

**Figure 2.1 – GHS Required Sections of a Safety Data Sheet**










### 2.1.2 Chemical Labeling

The GHS standardized label elements, which are not subject to variation and must appear on the chemical label, contain the following elements:

- Symbols (hazard pictograms) are used to convey health, physical and environmental hazard information, assigned to a GHS hazard class and category;
- Signal Words such as "Danger" (for more severe hazards) or "Warning" (for less severe hazards), are used to emphasize hazards and indicate the relative level of severity of the hazard assigned to a GHS hazard class and category;
- Hazard statements (e.g., "Danger! Extremely Flammable Liquid and Vapor") are standard phrases assigned to a hazard class and category that describe the nature of the hazard; and
- Precautionary statements are recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to the hazardous chemical.


The GHS also standardizes the hazard pictograms that are to be used on all hazard labels and SDSs. There are 9 pictograms that represent several defined hazards, and include the harmonized hazard symbols which are intended to convey specific information about each hazard. Figure 2.2 illustrates these GHS hazard pictograms.



|   |  |  |
|---|--|--|
|                      |   |   |
| <b>Carcinogen, Respiratory Sensitizer, Reproductive Toxicity, Target Organ Toxicity, Mutagenicity</b> | <b>Flammable, Pyrophoric, Self-Heating, Emits Flammable Gas, Organic Peroxide</b>  | <b>Irritant, Dermal Sensitizer, Acute Toxicity (harmful), Narcotic Effects</b>       |
|                      |   |   |
| <b>Gas Under Pressure</b>   | <b>Corrosive</b>   | <b>Explosive, Organic Peroxide, Self-Reactive</b>                                    |
|                     |  |  |
| <b>Oxidizer</b>   | <b>Environmental Toxicity</b>  | <b>Acute Toxicity (Severe)</b>   |

**Figure 2.2 – GHS Hazard Pictograms**

GHS labeling requirements are only applicable to chemical manufacturers, distributors, and shippers of chemicals. GHS labeling requirements are not required for chemicals being stored in a laboratory. However, since most chemicals stored in the laboratory have been purchased from a chemical manufacturer, the GHS labeling and pictogram requirements are very relevant and must be understood by laboratory employees. Figure 2.3 illustrates the GHS label format showing the required elements.





| <b>ACETONE</b>   |   |
|--|---|
| <p style="text-align: center;"><b>PRODUCT IDENTIFIER</b></p> <p>Code:<br/>Product Name:</p>  | <p style="text-align: center;"><b>HAZARD PICTOGRAMS</b></p>   |
| <p style="text-align: center;"><b>SUPPLIER IDENTIFICATION</b></p> <p>Company Name:<br/>Address:<br/>Phone Number:</p>  | <p style="text-align: center;"><b>SIGNAL WORD</b><br/><b>Danger</b></p>   |
| <p style="text-align: center;"><b>PRECAUTIONARY STATEMENTS</b></p> <p>Keep away from heat, sparks, open flames, hot surfaces – No smoking.<br/>Avoid breathing dust, fumes, gas, mist, vapors, and spray.<br/><b>IF IN EYES:</b> Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.<br/>Repeated exposure may cause skin dryness and cracking.<br/><b>In Case of Fire:</b> Use water spray, alcohol-resistant foam, dry chemical, or carbon dioxide.<br/><b>First Aid:</b> Move out of dangerous area. Consult a physician. If inhaled, move person to fresh air. If not breathing, give artificial respiration. In case of skin contact, wash with soap and plenty of water. In case of eye contact, rinse thoroughly with plenty of water for at least 15 minutes. If swallowed, do not induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water, consult a physician.</p> | <p style="text-align: center;"><b>HAZARD STATEMENT</b></p> <p>Highly flammable liquid and vapor.<br/>Causes mild skin irritation.<br/>Causes serious eye irritation.<br/>May cause drowsiness or dizziness.</p> |

**Figure 2.3 – GHS Label Format**

As mentioned earlier, one of the objectives of GHS was to create a quantitative hazard classification system (numerical hazard classification is based on a 1 – 5 scale, 1 being the most hazardous and 5 being the least hazardous) based on physical characteristics such as flash point, boiling point, lethal dose of 50% of a population, reactivity, etc. Table 2.1 illustrates how the numerical hazard classification works for flammable liquids. More detailed information on GHS can be found on the OSHA website.

<https://www.osha.gov/dsg/hazcom/ghs.html>

**Table 2.1 – GHS Hazard Classification System for Flammable Liquids**

| Category | Criteria                                     | Pictogram   | Signal Word | Hazard Statement                     |
|----------|--|---|-------------|--------------------------------------|
| 1        | Flash point < 23 °C<br>Boiling point ≤ 35 °C |  | Danger      | Extremely flammable liquid and vapor |
| 2        | Flash point < 23 °C<br>Boiling point > 35 °C |  | Danger      | Highly flammable liquid and vapor    |
| 3        | Flash point ≥ 23 °C and < 60 °C              |  | Warning     | Flammable liquid and vapor           |
| 4        | Flash point ≥ 60 °C and ≤ 93 °C              |  | Warning     | Combustible liquid                   |
| 5        | There is no Category 5 for flammable liquids |   |             |                                      |

## 2.2 National Fire Protection Association Rating System

The NFPA system uses a diamond-shaped diagram of symbols and numbers to indicate the degree of hazard associated with a particular chemical. This system was created to easily and quickly communicate hazards to first responders in the event of an emergency situation. These diamond-shaped symbols are placed on chemical containers to identify the degree of hazard associated with the specific chemical or chemical mixture. The NFPA system is a common way to identify chemical hazards and should be understood by laboratory employees. The NFPA 704 numerical rating system is based on a 0 – 4 system; 0 meaning no hazard and 4 meaning the most hazardous (note: this in contrast to the GHS system of 1 –5 where 1 is the most hazardous and 5 is the least hazardous). Figure 2.4 illustrates the NFPA hazard rating system and identifies both the hazard categories and hazard rating system.

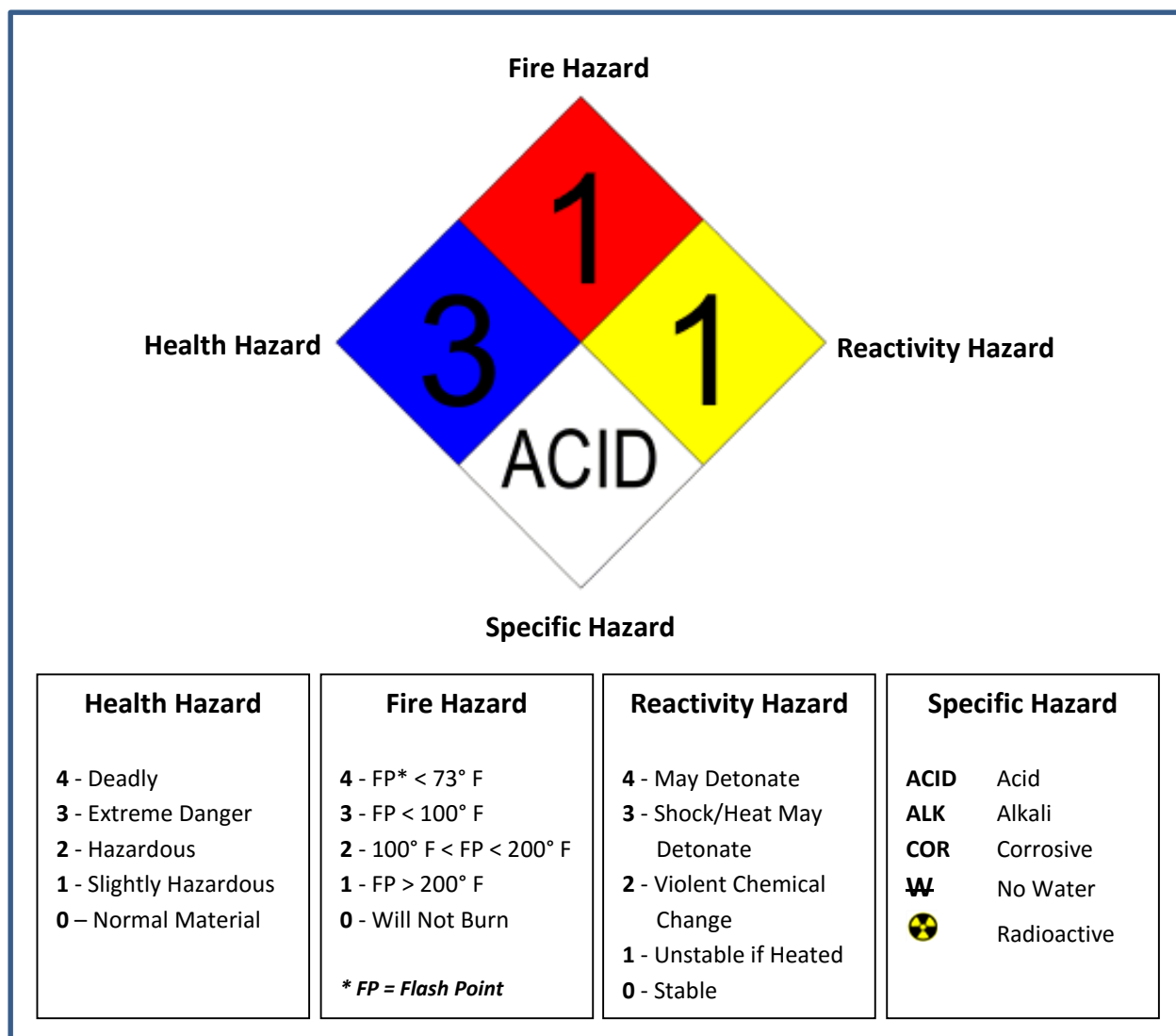


Figure 2.4 – NFPA Hazard Rating System










### 2.3 Department of Transportation Hazard Classes

The DOT regulates the transportation of all hazardous materials in the United States, and defines a hazardous material as any substance that has been determined to be capable of posing an unreasonable risk to health, safety, or property when transported in commerce. There are several methods that can be employed to determine whether a chemical is hazardous for transport, a few of which included:

- Reviewing the DOT Hazardous Materials Table (49 CFR 172.101);
- Reviewing the SDS, specifically Section 2: Hazardous Identification and Section 14: Transport Considerations, for the chemical being shipped, as detailed above in Section 2.1.1 of the CHP;

- Reviewing the chemical label and looking for hazard information detailed above in Section 2.1.2 of the CHP; and
- Understanding the chemical and physical properties of the chemical.

All hazardous chemicals must be properly labeled by the chemical manufacturer or distributor before transportation occurs. Chemical containers stored in laboratories are not required to be labeled per DOT standards; however the DOT 9 hazard classes are often seen on chemical containers and are discussed in Section 14 of GHS-formatted SDSs. The DOT 9 hazard classes are illustrated below in Figure 2.5. It should be noted that Figure 2.5 only lists the primary hazard classes, the sub classes (e.g., Organic Peroxides, DOT Class 5.2) were omitted for stylistic purposes.

|   |   |   |
|---|---|---|
|    |    |    |
| <b>DOT Class 1<br/>Explosives</b>   | <b>DOT Class 2<br/>Compressed Gases</b>   | <b>DOT Class 3<br/>Flammable Liquids</b>  |
|  |  |  |
| <b>DOT Class 4<br/>Flammable Solids</b>   | <b>DOT Class 5<br/>Oxidizers</b>  | <b>DOT Class 6<br/>Poisons</b>  |
|  |  |  |
| <b>DOT Class 7<br/>Radioactive Materials</b>  | <b>DOT Class 8<br/>Corrosives</b>   | <b>DOT Class 9<br/>Miscellaneous</b>  |

**Figure 2.5 – NFPA Hazard Rating System**

## Chapter 3: Classes of Hazardous Chemicals

Chemicals can be divided into several different hazard classes. The hazard class provides information to help determine how a chemical can be safely stored and handled. Each chemical container, whether supplied by a chemical manufacturer or produced in the laboratory, must have a label that clearly identifies the chemical constituents. In addition to a specific chemical label, more comprehensive hazard information can be found by referencing the SDS for that chemical. The OSHA Laboratory Standard defines a hazardous chemical as any element, chemical compound, or mixture of elements and/or compounds which is a physical or health hazard. This definition of a hazardous chemical and the GHS primary classes of chemicals are briefly discussed below.

### 3.1 Physical Hazards

A chemical is a physical hazard if there is scientifically valid evidence that it is flammable, combustible, water reactive, explosive, organic peroxide, oxidizer, pyrophoric, self-heating, self-reactive, or a compressed gas. Each physical hazard is briefly defined below. Refer to Appendix B (section B.1) for detailed information on each physical hazard.

- **Explosives:** A liquid or solid which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.
- **Flammable Liquids:** Materials which under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source and have a flash point no greater than 93 °C (200 °F).
- **Flammable Solid:** A solid which is readily combustible, or may cause or contribute to a fire through friction.
- **Gases under Pressure:** Gases which are contained in a receptacle at a pressure not less than 280 kPa at 20 °C or as a refrigerated liquid.
- **Organic Peroxide:** A liquid or solid which contains the bivalent -O-O- structure and may be considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals.
- **Oxidizer:** A liquid or solid, while in itself is not necessarily combustible, may generally by yielding oxygen, cause or contribute to the combustion of other material.
- **Pyrophoric Substance (also called Spontaneously Combustible):** A liquid or solid that even in small quantities and without an external ignition source can ignite after coming in contact with the air.

- **Self-Heating Substance:** A liquid or solid, other than a pyrophoric substance, which, by reaction with air and without energy supply, is liable to self-heat.
- **Self-Reactive Substance:** A liquid or solid that is liable to undergo strong exothermic thermal decomposition even without participation of oxygen (air).
- **Water-Reactive Substance:** A liquid or solid that reacts violently with water to produce a flammable or toxic gas, or other hazardous conditions.

### 3.2 Health Hazards

A chemical is a health hazard if there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Each health hazard is briefly defined below. Refer to Appendix B (section B.2) for detailed information on each health hazard.

- **Carcinogens:** Substances that cause cancer. Generally they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period. Carcinogens are separated into two classes: select carcinogens and regulated carcinogens.
- **Corrosives:** Substances that cause destruction of living tissue by chemical corrosion at the site of contact and can be either acidic or caustic (basic).
- **Hazardous Substances with Toxic Effects on Specific Organs:** Substances that pose adverse health effects to specific organs such as the liver, kidneys, lungs, etc.
- **High Acute Toxicity Substances:** Substances that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. Acute toxins are quantified by a substance's lethal dose-50 (LD50) or lethal concentration-50 (LC50), which is the lethal dose of a compound to 50% of a laboratory tested animal population (e.g., rats, rabbits) over a specified time period.
- **Irritant:** Substances that cause reversible inflammatory effects on living tissue by chemical action at the site of contact.
- **Reproductive Toxins:** Substances that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogens).
- **Sensitizer (also called allergen):** A substance that causes exposed individuals to develop an allergic reaction in normal tissue after repeated exposure to the substance.

### 3.3 Biological Hazards

The Purdue University Institutional Biosafety Committee (IBC) is the campus-based committee that has the responsibility for reviewing and approving all proposals, activities, and experiments involving an organism or product of an organism that presents a risk to humans, plants, animals, or the environment. The Laboratory Supervisor must submit to the IBC an application to use rDNA, synthetic nucleic acids, potential pathogens, human tissue, fluids, and/or cell lines in their research. The IBC review is conducted in accordance with the guidance and requirements of National Institutes of Health, the Centers for Disease Control, and Purdue University policies, and the Biosafety Manual. All Laboratory Supervisors have an obligation to be closely familiar with EHS guidelines applicable to their work and to adhere to them. More detail regarding the IBC process can be found on the Purdue Office of the Vice President for Research website:

(<http://www.purdue.edu/research/vpr/rschadmin/rschoversight/rdna/forms.php>).

### 3.4 Radioactive Material Hazards

The Purdue University Radiation Safety Committee (RSC) is the campus-based committee that has the responsibility for reviewing and approving all proposals, activities, and experiments involving radioactive material and radiation producing devices. The Laboratory Supervisor must submit to the RSC through REM, an application to use radioactive material or radiation-producing devices. Use of radioactive materials at Purdue University is authorized under a license issued by the US Nuclear Regulatory Commission or a registration with the Indiana State Department of Health and all work must comply with applicable regulations. The policies and procedures for handling radioactive materials are contained in the *Purdue University Radiation Safety Manual*. (<http://www.purdue.edu/ehps/rem/home/booklets/radman.pdf>)

### 3.5 Laser Hazards

The Purdue University Laser Safety Committee (LSC) is the campus-based committee that has the responsibility for reviewing and approving all proposals, activities, and experiments involving laser radiation devices. Laboratory Supervisors must submit to the LSC through REM, an application to use Class 3B and Class 4 lasers or laser devices. The use of lasers is subject to OSHA regulations and utilizes current ANSI standards to develop guidance. The policies and procedures for handling lasers are contained in the *Purdue University Laser Safety Guidelines*. (<http://www.purdue.edu/ehps/rem/home/booklets/laserguide.pdf>)



## Chapter 4: Laboratory Safety Controls

Laboratory safety controls include engineering controls, administrative controls, and PPE. Elements of these three categories should be used in a layered approach to minimize employee exposure to hazardous chemicals. The hierarchy of controls prioritizes hazard mitigation strategies on the premise that the best way to control a hazard is to systematically eliminate it from the workplace or substitute a less hazardous technique, process, or material. If elimination or substitution are not feasible options, administrative controls, engineering controls, and PPE must be used to provide the necessary protection. The laboratory employee's responsibility is to follow administrative controls, use engineering controls, and wear PPE correctly and effectively.

### 4.1 Routes of Exposure

There are four primary routes of exposure in which hazardous substances can enter the body: inhalation, absorption, ingestion, and injection. Of these, the most likely routes of exposure in the laboratory are by inhalation or skin absorption. Many hazardous chemicals may affect people through more than one of these exposure modes, so it is critical that protective measures are in place for each of these exposure routes.

### 4.2 Engineering Controls and Safety Equipment

Exposure to hazardous materials must be controlled to the greatest extent feasible by use of engineering controls. Engineering controls that reduce or eliminate exposures to hazardous chemicals include:

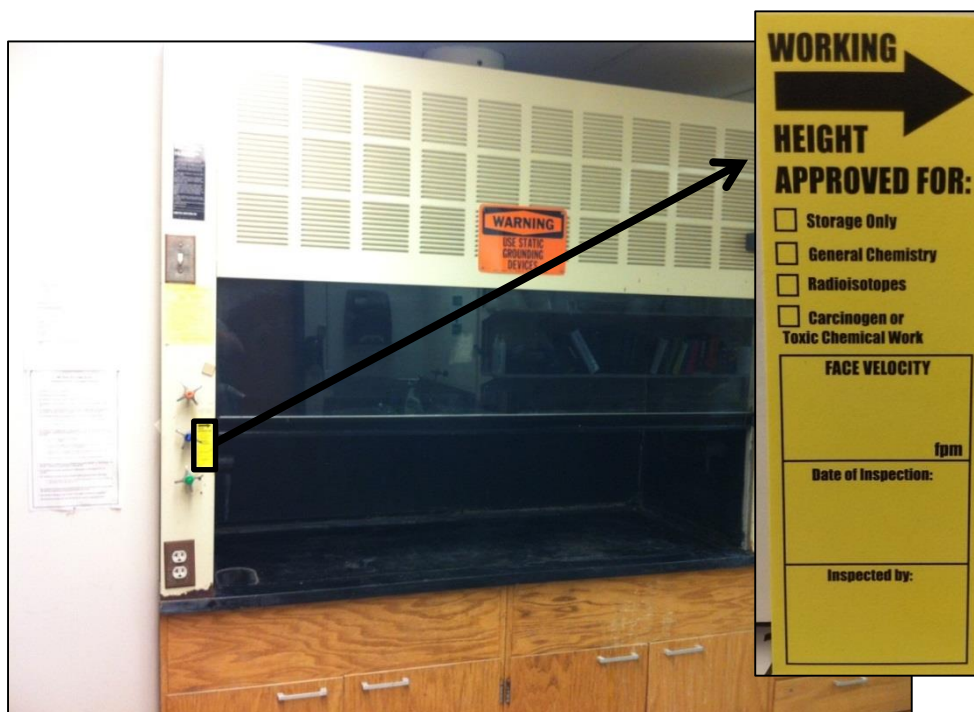
- Substitution with less hazardous equipment, chemicals, or processes (e.g., safety cans for glass bottles);
- Isolation of the operator or the process (e.g., use of a glove box when handling air- or water-sensitive chemicals); and
- Use of forced ventilation systems (e.g., chemical fume hood, biological safety cabinet).

#### 4.2.1 Chemical Fume Hoods

A chemical fume hood is a type of local ventilation installation that is designed to limit exposure to hazardous or toxic fumes, vapors, or dusts. To determine if a chemical is required to be used inside of a chemical fume hood, first check the SDS for that chemical. Statements found in Section 2 on a SDS such as "do not breathe dust, fumes, or vapors" or

“toxic by inhalation” indicate the need for ventilation. As a best practice, always use a chemical fume hood for all work involving the handling of open chemicals (e.g., preparing solutions, transferring chemicals) whenever possible. If a chemical fume hood is required or recommended to be used, the following guidelines must be followed at all times:

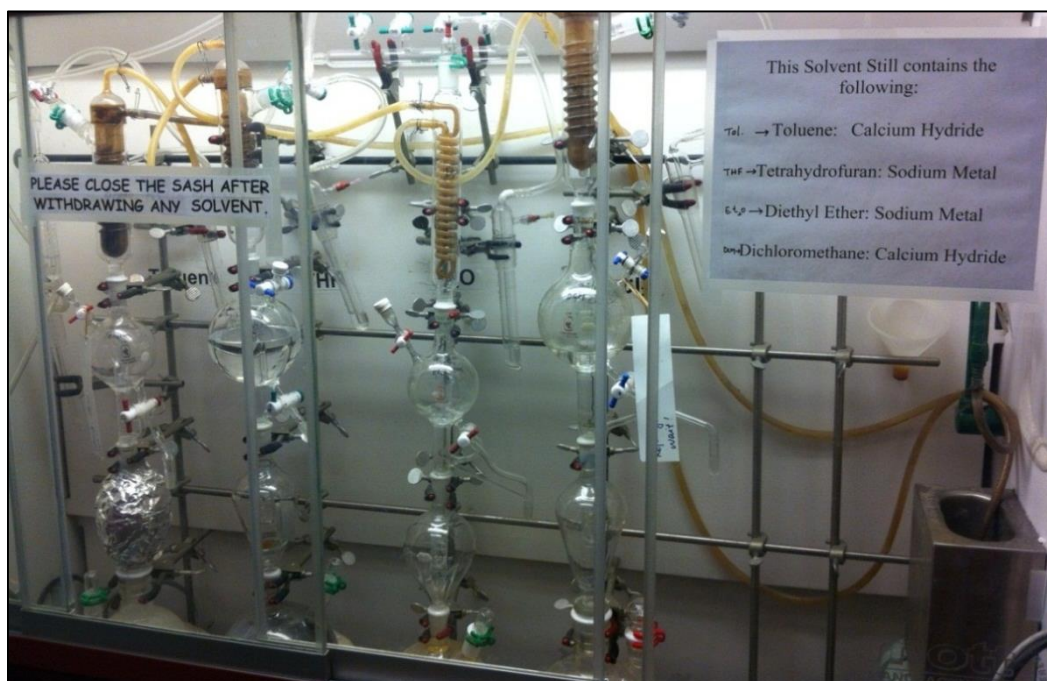
- Chemical fume hoods must be marked to indicate the proper sash position for optimum hood performance as illustrated in Figure 4.1. The chemical fume hood sash should be positioned at this height whenever working with hazardous chemicals that could generate toxic aerosols, gases, or vapors. In general, the sash height should be set at a level where the operator is shielded to some degree from any splashes, explosions, or other violent reactions which could occur and where optimum air flow dynamics are achieved. Most chemical fume hoods are not intended to be used with the sash fully open. The sash should only be fully opened to add or remove equipment from the chemical fume hood.



**Figure 4.1 – Chemical Fume Hood Sash Approved Working Height**

- Chemical fume hoods must be equipped with a continuous reading monitoring device to indicate the adequacy of flow. All lab employees must know how to read and interpret this gauge and check that the fume hood is operating properly before using hazardous chemicals in the fume hood. There are many different types of chemical fume hoods on campus, so it is important that the lab employee understands the specific functions of each chemical fume hood used in the lab.

- Only apparatus and chemicals essential to the specific procedure or process should be placed in the chemical fume hood. Extraneous materials from previous experiments should be removed and stored in a safe location outside the chemical fume hood.
- Chemical fume hoods used for experimental work should not be used for chemical or equipment storage. Fume hoods used for chemical storage should only be used for storage; experimental work should not be conducted in these hoods.
- All chemical containers used in fume hoods, including secondary containers (e.g., beakers, flasks, reaction vessels, vials, etc.) must be labeled. If it is not practical to label a secondary container that is in process (e.g., reaction vessel, flask), a temporary label can be used as shown in Section 5.7 of the CHP. Reaction vessels in chemical fume hoods must also be labeled. If labeling the vessel itself is not practical, the hood sash or wall may be labeled as illustrated in Figure 4.2.



**Figure 4.2 – Alternative Labeling of Chemical Fume Hood Reaction Vessels**

- Do not allow the vents or air flow baffles to be blocked, as this can interfere with the designed and optimal air flow of the chemical fume hood.
- Never put your head inside of an operating chemical fume hood.
- All chemical fume hoods should be routinely checked for airflow by measuring the face velocity, which should be between 70 – 125 feet per minute. REM conducts face velocity readings on a routine basis and records this information on the hood label. Contact REM with questions regarding chemical fume hoods (765) 494-6371.

### 4.2.2 Glove Boxes

A glove box, as illustrated in Figure 4.3, is a sealed container that is designed to allow material to be handled in a specific atmosphere (typically inert). Glove boxes can be used to protect sensitive items inside the glove box or the user on the outside of the glove box, or both. The following recommendations should be followed by all personnel using a glove box:



**Figure 4.3 – Glove Box**

- All personnel must receive documented training from the Laboratory Supervisor or delegate before any work in a glove box occurs. All trained personnel must understand the design features and limitations of the glove box before use. The training must include detailed instruction on elements such as the ventilation and vacuum controls that maintain a pressure differential between the glove box and outside atmosphere, atmospheric controls (e.g., controlling oxygen concentrations and moisture), etc.
- Prior to use, a visual glove inspection must be performed. Changing of a glove must be documented (date, manufacturer, model of glove, and person performing change). Gloves should not be used until they fail; they should be changed according to the glove box manufacturer's recommendations or whenever necessary.
- Plugging ports that are never or infrequently used is recommended. A properly plugged port should have a stub glove and a glove port cap installed.
- Chemical resistant gloves (e.g., disposable nitrile gloves) should be used under the glove box gloves to protect from contamination.

- The glove box gloves should be cleaned on a routine basis (before each use is recommended) as a good hygiene practice.
- The glove box pressure must be checked before use and immediately after gloves are changed. The pressure check should be documented.
- Keep sharps in an approved container while in the glove box.
- Do not work in the glove box unless the lighting is working.
- Follow all safe work practices for using and handling compressed gas that may be associated with working in the glove box. Follow the manufacturer's recommendations.
- All equipment and chemicals in the glove box must be organized and all chemicals must be labeled. Do not allow items, particularly chemicals to accumulate in the glove box.

### 4.2.3 Laminar Flow Clean Benches

A laminar flow clean bench, as shown in Figure 4.4, is an enclosed bench designed to prevent contamination of semiconductor wafers, samples, or any particle sensitive device. Air is drawn through a filter and blown in a very smooth, laminar flow towards the user. Therefore it is critical that absolutely no hazardous chemicals, infectious and/or radioactive materials ever be used in a laminar flow clean bench, as the vapors are blown directly towards the user. Applications that involve the use of chemicals should be conducted in chemical fume hoods.



**Figure 4.4 – Laminar Flow Clean Bench**

#### 4.2.4 Biological Safety Cabinets

A biological (or biosafety) safety cabinet, as shown in Figure 4.5, is an enclosed, ventilated laboratory workspace used for safely working with materials contaminated with (or potentially contaminated with) infectious materials. The primary purpose of a biosafety cabinet is to serve as a means to protect the laboratory worker and the surrounding environment from pathogens. All exhaust air is filtered as it exits the biosafety cabinet, removing harmful particles. Biological safety cabinets are not designed to be used with chemical applications so the use of chemicals should be kept to a minimum. Applications that involve the use of chemicals should be conducted in chemical fume hoods.



**Figure 4.5 – Biological Safety Cabinet**

#### 4.2.5 Safety Showers and Eyewash Stations

All laboratories using hazardous chemicals must have immediate access to safety showers and eye wash stations. Safety showers must have a minimum clearance of 24 inches from the centerline of the spray pattern in all directions at all times. Identify the safety station with a highly visible sign and maintain an unobstructed path to it. All lab personnel must be aware of the location and know how to properly use the safety shower and eyewash stations.

If lab personnel are exposed to a hazardous chemical, they should dial 911 (or someone else in the lab that is not exposed should dial 911) and use the safety shower and/or eye wash unit for 15 minutes or until emergency response have personnel arrive and begin

treatment. If an uninjured individual is present, this person should assist with the decontamination of the affected individual.

All eyewash stations must be flushed by laboratory personnel on a weekly basis to ensure proper working order. This will keep the system free of sediment and prevent bacterial growth from reducing performance. REM performs annual inspections of all campus safety shower and eyewash stations. This inspection evaluates the basic mechanical functionality of each station. Any deficiencies are repaired either by REM staff or by Purdue Physical Facilities maintenance staff. If the safety shower or eye wash unit becomes inoperable, notify your building deputy immediately.

#### 4.2.6 Fire Extinguishers

All fire extinguishers should be mounted on a wall in an area free of clutter. Each fire extinguisher on campus is inspected on an annual basis by the Purdue Fire Department. All laboratory personnel should be familiar with the location, use, and classification of the extinguishers in their laboratory. Ensure that the fire extinguisher being used is appropriate for the type of material on fire before attempting to extinguish any fire. Table 4.1 illustrates the fire classification system, which should be used to determine the most suitable fire extinguisher for a particular area. Laboratory personnel are not required to extinguish fires that occur in their work areas and should not attempt to do so unless:

- It is a small, contained fire that can be quickly and safely extinguished (e.g., small trashcan sized fire);
- Appropriate training has been received and the individual feels the fire can be safely extinguished; and
- It is necessary to extinguish a fire in order to safely exit an area (e.g., fire is blocking an exit).

If a fire occurs in the laboratory and is extinguished by lab personnel, the Purdue University Fire Department must still be contacted immediately by dialing 911. It is common for fires to reignite so it is critical that the Purdue Fire Department still be contacted.

**Table 4.1 – Fire Classifications System**

| Classification | Fire Type                      |
|----------------|--------------------------------|
| Class A        | Ordinary fire (wood and paper) |
| Class B        | Flammable liquids and gases    |
| Class C        | Electric fire                  |
| Class D        | Combustible metal fire         |
| Class K        | Kitchen fire                   |

### 4.2.7 Fire Doors

Many laboratories may contain fire doors as part of the building design. These doors are an important element of the fire containment system and should remain closed unless they are on a magnetic self-closure or other automated self-closing system. Never disable an automatic door closure device (e.g., placing a block under the door). If you are unsure of whether a door is fire rated or not, contact REM at (765) 494-6371 and a staff member will come to the area to evaluate the specific door in question.

## 4.3 Administrative Controls

Administrative controls are procedural measures which can be taken to reduce or eliminate hazards associated with the use of hazardous materials. Administrative controls include, but are not limited to, the following:

- Ensuring that employees are provided adequate documented training for safe work with hazardous materials
- Careful planning of experiments and procedures with safety in mind; planning includes the development of written SOPs and hazard assessments (discussed in detail in Chapter 6) for safe performance of the work
- Discussing safety on a regular basis (e.g., during lab meetings) and creating an atmosphere where people feel comfortable talking about safety
- Restricting access to areas where hazardous materials are used
- Using safety signs or placards to identify hazardous areas (designated areas)
- Labeling all chemicals
- Substitution of toxic materials with less toxic materials, when possible
- Good housekeeping and good personal hygiene such as routine hand washing and regular decontamination of areas that are possibly chemically contaminated such as bench-tops and fume hoods
- Prohibiting eating and drinking where chemicals are used or stored



### 4.3.1 Standard Operating Procedures

SOPs are written instructions that detail the steps that will be performed during a given procedure and include information about potential hazards and how these hazards will be mitigated. SOPs must be prepared by laboratory personnel who are the most



knowledgeable and involved with the experimental process. However, the Laboratory Supervisor is ultimately responsible for approving SOPs regardless of who prepares them.

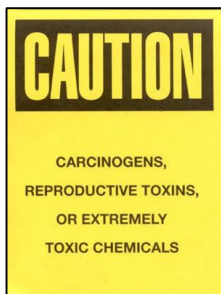
The OSHA Lab Standard requires SOPs to be developed for all hazardous tasks that are performed in the lab. This would include work with hazardous chemicals (e.g., flammable liquids, compressed gases, etc.) and also work with hazardous equipment/operations (e.g., solvent distillation, hydrogenation, centrifuge, etc.). An individual SOP is not required for every hazardous task performed or chemical used in the lab; SOPs can be written in a comprehensive manner that encompasses many similar hazards. For example, if a procedure in the lab requires the use of acetone and ethyl acetate, both of which are flammable liquids, one SOP on flammable liquids can be created rather than a separate SOP for both acetone and ethyl acetate. To assist researchers in complying with the OSHA Lab Standard, REM has developed SOP templates that can be used by laboratories. These SOPs are not complete as is; they are templates that must be customized by each laboratory before they are considered complete. Instructions for completion are included in each SOP template. Laboratories are encouraged to use these templates to develop their own SOPs. Contact REM at (765) 494-0121 if assistance is needed with developing lab-specific SOPs. For the up to date list of SOP templates, visit the REM website.

<http://www.purdue.edu/ehps/rem/home/sop.htm>

### 4.3.2 Required Laboratory Postings

The following forms and labels are required to be posted by most campus laboratories:

- The Laboratory Information door posting is required for all laboratories. <http://www.purdue.edu/ehps/rem/home/forms/doorpost.pdf>
- The Certification of Hazard Assessment form is required for all laboratories. Detailed information regarding the hazard assessment process is presented in Section 6.3 of the CHP.
- The Carcinogens, Reproductive Toxins, or Extremely Toxic Chemicals label (Toxic Chemicals Label), which is illustrated in Figure 4.6 is required if a lab uses or stores any chemicals on the list linked below. Contact REM (765) 494-6371 to request Toxic Chemicals Labels. <http://www.purdue.edu/ehps/rem/home/booklets/crdalist.pdf>



**Figure 4.6 – Toxic Chemicals Label**

- The Abbreviations and Chemical Formulas list is required for all labs that use abbreviations and/or chemical formulas as a means to label chemical containers, including secondary containers such as beakers, flasks, and vials. This list, which can be found on the REM website, is not all inclusive and any abbreviations not listed must be added by laboratory personnel.

(<http://www.purdue.edu/ehps/rem/home/booklets/abbreviations.xlsx>)

There are several other lab postings that may also be required that are not discussed in the CHP, particularly if radioisotopes and/or biological agents are used in the lab. This information should be obtained by reviewing the Radiation Safety Manual and/or Biological Safety Manual. Additional information regarding lab postings and labels can be found on the REM website. (<http://www.purdue.edu/ehps/rem/home/contlabl.htm>)

#### **4.4 Personal Protective Equipment (PPE)**

Personal protective equipment (PPE) should be used to supplement engineering controls. However, PPE should never be used as a substitute for engineering controls when engineering controls are required. PPE must be worn at all time in the laboratory when handling hazardous chemicals. Proper PPE selection can be determined in the following ways:

- Ask the Laboratory Supervisor about proper PPE selection.
- Review the SOP and associated hazard assessment for the task to be performed.
- Review Section 8, “Exposure Controls/Personal Protection” of the SDS for the chemical(s) being used. This will provide basic information on the PPE recommended for use with the particular chemical. The SDS addresses “worst case” conditions; therefore, all the equipment described may not always be necessary for a specific task. In addition, the SDS may not provide sufficient information concerning a specific respirator or type of glove appropriate for the chemical.

Additional PPE requirements are detailed in the Laboratory PPE Policy in Chapter 6 and Chapter 9 of the CHP.

## Chapter 5: Laboratory Management Plan

An effective laboratory management plan is essential to operating a safe lab environment. Requirements on topics such as lab housekeeping, equipment safety, chemical inventories, proper handling, storage, segregation, and labeling of chemicals must be established and known by all laboratory personnel. This chapter details how laboratories should be safely managed at Purdue.

### 5.1 Laboratory Safety Guidelines

All laboratory employees must have a good understanding of the hazards associated with the chemicals being used and stored in the lab. Basic factors such as the physical state (gas, liquid, or solid) of the chemical and the type of facilities and equipment involved with the procedure should be considered before any work with hazardous materials occurs.

#### 5.1.1 Laboratory Safety Considerations

Many factors are involved in an effective laboratory safety program. Considering the following questions will help address many of the factors that should be considered before work in the lab begins:

- Is the material flammable, explosive, corrosive, or reactive?
- Is the material toxic, and if so, how can I be exposed to the material (e.g., inhalation, skin or eye contact, accidental ingestion, accidental puncture)?
- What kind of ventilation do I need to protect myself?
- What kind of PPE (e.g., chemical-resistant gloves, respirator, and goggles) do I need to protect myself?
- Will the process generate other toxic compounds, or could it result in a fire, explosion, or other violent chemical reaction?
- What are the proper procedures for disposal of the chemicals?
- Do I have the proper training to handle the chemicals and carry out the process?
- Are my storage facilities appropriate for the type of materials I will be using?
- Can I properly segregate incompatible chemicals?
- What possible accidents can occur and what steps can I take to minimize the likelihood and impact of an accident? What is the worst incident that could result from my work?

### 5.1.2 General Laboratory Safety Rules

It is extremely important that all laboratory safety rules are known and followed by lab personnel. Not only is it important that the rules are understood and followed, it is also important that the Laboratory Supervisor enforce all lab safety rules. A culture of safety must be adopted by all employees before a lab safety program can be successful. The following general laboratory safety rules should be followed at all times:

- Prior to beginning work in the lab, be prepared for hazardous materials emergencies and know what actions to take in the event of an emergency. Plan for the worst-case scenario. Be sure that necessary supplies and equipment are available for handling small spills of hazardous chemicals. Know the location of safety equipment such as the nearest safety shower and eyewash station, fire extinguisher, spill kit, and fire alarm pull station.
- Do not work alone in the lab if you are working with high hazard materials (e.g., acutely toxics, reactives, or processes that involve handling a large volume of flammable materials, > 1 liter).
- If working with a high-hazard chemical, ensure that others around you know what you are working with and understand the potential hazards.
- Limit access to areas where chemicals are used or stored by posting signs and/or locking doors when areas are unattended.
- Purchase the minimum amount of hazardous materials necessary to efficiently operate the laboratory.
- Ensure that adequate storage facilities (e.g., chemical storage rooms, flammable safety cabinets) and containers are provided for hazardous materials. Ensure that hazardous materials are properly segregated by chemical compatibility.
- Ensure that ventilation is adequate for the chemicals being used. Understand how chemical fume hoods function and be able to determine if the hood is not functioning properly.
- Use good personal hygiene practices. Keep your hands and face clean; wash thoroughly with soap and water after handling any chemical. Do not handle your cell phone while wearing protective gloves.
- Smoking, drinking, eating, and the application of cosmetics are forbidden in areas where hazardous chemicals are in use. Confine long hair and loose clothing.
- Never smell or taste a hazardous chemical. Never use mouth suction to fill a pipette.
- When using equipment that creates potential hazards (e.g., centrifuge), ensure that the equipment is being used following the manufacturer's guidelines and

instructions. If equipment requires routine maintenance (e.g., HEPA filters need to be changed), ensure the maintenance is performed by a qualified individual.

- Use required PPE as instructed by the PPE Policy detailed in Chapter 6.

## 5.2 Housekeeping

Housekeeping is an important element to a laboratory safety program. A clean, well-maintained lab improves safety by preventing accidents and can enhance the overall efficiency of the work being performed. The following laboratory housekeeping guidelines should be followed:

- All doorways and hallways must be free of obstructions to allow clear visibility and exit. The laboratory should be uncluttered without excessive storage of materials that could cause or support a fire (e.g., paper, cardboard, flammable liquids, etc.).
- Fire protection sprinklers must be unobstructed; a minimum of 18 inches of clearance is required below the sprinkler head. If the laboratory does not have fire protection sprinklers, there must be a minimum of 24 inches of clearance below the ceiling.
- Do not store items that block fire extinguishers or eyewash and safety shower stations.
- Do not store items in front of electrical boxes/panels in the lab.
- A routine cleaning schedule should be established. All work surfaces should be kept as clean as possible. All potentially chemically contaminated work area surfaces (e.g., chemical fume hood deck, countertops) should be cleaned routinely (e.g. daily, weekly).
- For operations where spills and contamination are likely (e.g., agarose gel electrophoresis/ethidium bromide applications), cover work spaces with a bench paper or liner. The soiled bench paper should be changed on a routine basis or as needed.
- All chemical spills must be cleaned up immediately. Refer to Chapter 8 of the CHP for detailed chemical spill cleanup procedures.
- Do not allow materials to accumulate in lab fume hoods and remove used tissues, foil, gloves, razor blades, or other unnecessary objects immediately after use. The safety of the workspace and the hood ventilation may be compromised when excessive chemicals and equipment are kept in hoods.
- Ensure that all waste (e.g., trash, chemically contaminated debris waste, etc.) is placed in the appropriate containers. Do not overfill waste containers.
- All equipment should be cleaned and returned to storage after each use.
- Equipment should be stored in a safe and orderly manner that prevents it from falling.
- Chemical containers must be clean, properly labeled, and returned to storage upon completion or usage. Avoid storing liquids above eye level.
- Do not store heavy or frequently used items on top shelves. Locate items used daily close to the work area.

### 5.3 Chemical Inventories

It is a prudent practice to develop and maintain a chemical inventory. Taking a routine chemical inventory can reduce the number of unknown chemicals and the tendency to stockpile chemicals. REM recommends that all laboratories take a chemical inventory at least annually. Depending on the type of chemicals being used and stored in a laboratory, REM may require that a chemical inventory be prepared for a room, work unit, or department (e.g., Department of Homeland Security Chemical Facility Anti-Terrorism Standards Inventory) on a routine basis.

### 5.4 Safety Data Sheets

The SDS provides comprehensive information that is imperative for the safe handling of hazardous chemicals. Carefully read the label and SDS and make sure that you understand the information provided in this document before using a chemical. In some cases it may be necessary to do additional research. The Laboratory Supervisor should be consulted if necessary. REM is also a good resource if additional information is needed.

It is important that all lab employees have access to SDS for all hazardous chemicals that are stored in the lab. Access can mean storing hard copies of SDS in the lab or some other easily accessible location (e.g., departmental main office), or can mean storing electronically by a means that is also accessible to all lab personnel (e.g., shared network drive). To obtain a copy of a SDS, contact the chemical manufacturer or REM at (765) 494-6371. Many manufacturers' SDS can be found online at REM's SDS webpage or other websites such as Siri MSDS Index. The links to these resources are included below:

- REM SDS Search (<http://www.purdue.edu/ehps/rem/home/msds.htm>)
- Siri MSDS Index (<http://hazard.com/msds/>)
- Sigma-Aldrich Product Search (<http://www.sigmaaldrich.com/united-states.html>)

### 5.5 Chemical Labeling Requirements

Every chemical container present in the laboratory, whether hazardous or not, must be properly labeled. All secondary chemical containers (e.g., wash bottles, beakers, flasks, sample vials, etc.) must also be properly labeled. Avoid using abbreviations, chemical formulae, or structure unless there is a complete and up-to-date legend (e.g., MeOH = Methanol)



prominently posted in the lab. Most chemicals come with a manufacturer label that contains all of the necessary information, so care should be taken to not damage or remove these labels. It is recommended that each bottle also be dated when received and when opened to assist in determining which chemicals are expired and require proper disposal. Detailed information and strategies for the labeling of research samples is discussed in Section 5.13 of the CHP. These same strategies can be used when labeling secondary chemical containers as well.

## 5.6 Chemical Segregation

All chemicals must be stored according to chemical compatibility. Once segregated by chemical compatibility, they can then be stored alphabetically. Information regarding chemical compatibility can be found in the SDS, primarily in Section 7, "Handling and Storage" and Section 10, "Stability and Reactivity". If unsure of proper segregation procedures, contact the Laboratory Supervisor or REM for assistance. Chemical segregation can be achieved by either isolation (e.g., organic solvents stored in a flammable cabinet), physical distance (e.g., acids and bases are stored on opposite sides of a chemical storage room), or secondary containment (e.g., placing oxidizing acids such as nitric acid into a secondary containment to segregate from organic acids such as formic acid as shown in Figure 5.7). In the most general terms, proper segregation can be achieved by:

- Storing acids away from bases and toxics;
- Storing oxidizers away from organic chemicals; and
- Storing reactive and acutely toxic materials away from all other chemicals.

Table 5.1 illustrates a more detailed chemical compatibility logic that can be used for chemical storage. Hazard classes marked by an X need to be segregated from each other (e.g., Acid, inorganic must be segregated from Base, inorganic). Contact REM at (765) 494-0121 with questions regarding chemical segregation.



**Table 5.1 – Chemical Compatibility Chart**

|                  | Acid, inorganic | Acid, organic | Acid, oxidizer | Base, inorganic | Base, organic | Oxidizer | Toxic, inorganic | Toxic, organic | Reactive | Organic solvent |
|------------------|-----------------|---------------|----------------|-----------------|---------------|----------|------------------|----------------|----------|-----------------|
| Acid, inorganic  |                 |               |                | X               | X             |          | X                | X              | X        |                 |
| Acid, organic    |                 |               | X              | X               | X             | X        | X                | X              | X        |                 |
| Acid, oxidizer   |                 | X             |                | X               | X             |          | X                | X              | X        | X               |
| Base, inorganic  | X               | X             | X              |                 |               |          |                  |                | X        |                 |
| Base, organic    | X               | X             | X              |                 |               | X        |                  |                | X        |                 |
| Oxidizer         |                 | X             |                |                 | X             |          |                  | X              | X        | X               |
| Toxic, inorganic | X               | X             | X              |                 |               |          |                  |                | X        |                 |
| Toxic, organic   | X               | X             | X              |                 |               | X        |                  |                | X        |                 |
| Reactive         | X               | X             | X              | X               | X             | X        | X                | X              |          | X               |
| Organic solvent  |                 |               | X              |                 |               | X        |                  |                | X        |                 |

## 5.7 Chemical Storage Requirements

Proper storage of chemicals is an essential component to a laboratory safety program. Improper chemical storage practices can cause undesired chemical reactions, which may form hazardous products that can lead to employee exposure or possibly fires and property damage. All lab employees should carefully read each chemical's SDS and container label before deciding how to store a chemical, as these will often indicate any special storage requirements that may be necessary. The following subsections describe chemical storage requirements in more detail.

### 5.7.1 General Chemical Storage

The following general chemical storage guidelines must be followed in all laboratories:

- Each chemical in the laboratory must be stored in a specific location and returned there after each use. Acceptable chemical storage locations may include flammable cabinets, corrosive cabinets, fume hood cabinets, secure laboratory shelves, or appropriate laboratory refrigerators or freezers.
- Chemical containers must be in good condition and appropriate for the chemical that they contain and be free from exterior contamination.
- Chemical fume hoods should not be used as permanent chemical storage areas, unless designated as such. Not only does this create potentially unsafe conditions by having extraneous chemicals stored near chemical reactions and processes, excess

chemical bottles in the hood may also seriously impair the ventilating capacity of the fume hood. Only chemicals being used in the process or experiment being conducted in the fume hood are allowed to be stored in the fume hood and should be removed when the process or experiment is complete.

- Chemicals should not be permanently stored on bench tops. Avoid storing any chemical containers on the floor. Under no circumstance should chemical containers, or anything else, be stored in aisle ways, corridors, or in front of doors.
- Hazardous liquids should not be stored on shelves above eye-level unless there is a SOP detailing safe handling procedures.
- Chemicals should be stored at an appropriate temperature and humidity level and never be stored in direct sunlight.
- Periodic cleanouts of expired or unneeded chemicals should be conducted to minimize the volume of hazardous chemicals stored in the laboratory.
- Always follow the chemical manufacturer's storage instructions, if provided.

### 5.7.2 Flammable Liquids Storage

Flammable liquids include any liquid with a flash point no greater than 93 °C (200 °F). The following guidelines for storing flammable liquids must be followed in all laboratories:

- Flammable and combustible liquids should be stored in flammable storage cabinets, as shown in Figure 5.1, whenever possible. No more than 10 gallons of flammable liquid is permitted to be stored outside of a flammable storage cabinet unless it is stored in a flammable safety can equipped with a spring-loaded lid and an internal screen as shown in Figure 5.2.
- Domestic refrigerators or freezers must never be used to store flammable liquids. Flammable liquids can only be stored in refrigerators or freezers that are designed for flammable materials (Note: most refrigerators and freezers are not intended for flammable storage).
- Flammable liquids must be stored in well-ventilated areas free from ignition sources.
- Some organic solvents (e.g., diethyl ether, tetrahydrofuran) have a shelf-life and can form organic peroxides over time while in storage. These "peroxide formers" must be dated when received from the chemical manufacturer and disposed of once expired. If any time-sensitive chemicals are found to be past the manufacturer's expiration date, they must be submitted to REM for hazardous waste disposal immediately. See Appendix C for a list of commonly found organic solvents that potentially form organic peroxides.



**Figure 5.1 – Flammable Storage Cabinet**



**Figure 5.2 – Flammable Safety Can**

### 5.7.3 Compressed Gases Storage

Compressed gases are defined as gases that are contained in a receptacle at a pressure not less than 280 kPa at 20 °C or as a refrigerated liquid. The following guidelines for storing compressed gases must be followed in all laboratories:

- Compressed gas cylinders (cylinders) must be stored in a secure, well ventilated location, and in an upright position at all times. Small cylinders such as lecture bottles are not required to be stored in the upright position; they can be safely laid down in a chemical cabinet. However, when lecture bottles are in use they should be secured and stored in an upright position if at all possible.
- All cylinders should be handled as if full and should never be completely emptied.
- Cylinders that are not in use (meaning that the cap is on) must be secured and have the safety cap. Multiple cylinders may be secured together, only if they are capped (not in use). Only capped cylinders can be secured with a single restraining device as shown in Figure 5.3.
- Cylinders that are in use, meaning there is a regulator attached, must be individually secured by a chain or strap as shown in Figure 5.4. Cylinder valves and regulators should be protected from impact or damage.



**Figure 5.3 – Not In-Use Cylinders**



**Figure 5.4 – In-Use Cylinders**

#### 5.7.4 Reactive Materials Storage

Reactive materials include explosives, pyrophorics, self-heating and self-reacting compounds, and water-reactives. Many reactive materials are also toxic and are dissolved or immersed in a flammable solvent (e.g., lithium alkyl compounds dissolved in diethyl ether, sodium metal immersed in mineral oil). Other common hazards often associated with reactive chemicals include corrosivity, teratogenicity, or organic peroxide formation. The following guidelines for storing reactive materials must be followed in all laboratories:

- The amount of reactive materials stored in the lab must be kept to a minimum. Any expired or unnecessary reactive materials must be properly disposed of as hazardous waste.
- All reactive materials must be clearly labeled with the original manufacturer's label, which should have the chemical name, hazard labels, and pictograms. The label should not be defaced in any way.
- All reactive materials should be placed into secondary containment as a best management practice.
- Suitable storage locations for reactive materials include inert gas-filled desiccators or glove boxes, flammable storage cabinets that do not contain aqueous or other incompatible chemicals, or intrinsically safe refrigerators or freezers that also do not contain aqueous or other incompatible chemicals. If possible, store all reactive chemicals in a small flammable cabinet (such as a cabinet underneath a fume hood) dedicated only for reactives. Signs should be posted to indicate their presence and unique hazards as shown in Figure 5.5.



**Figure 5.5 – Reactive Chemicals Storage**

- Many reactive materials are water and/or air reactive and can spontaneously ignite on contact with air and/or water. Therefore, reactivities must be handled under an inert atmosphere and in such a way that rigorously excludes air and moisture.
- If reactive materials are received in a specially designed shipping, storage, or dispensing container (such as the Aldrich Sure-Seal packaging system), ensure that the integrity of that container is maintained. Ensure that sufficient protective solvent, oil, kerosene, or inert gas remains in the container while reactive materials are stored.

### 5.7.5 Acutely Toxic Materials Storage

Acutely toxic materials are defined as substances that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. The following guidelines for storing acutely toxic materials must be followed in all laboratories:

- Suitable storage locations for acutely toxic materials include desiccators, glove boxes, flammable storage cabinets that do not contain incompatible chemicals (primarily strong acids), or non-domestic refrigerators or freezers. These locations should be clearly posted.
- Acutely toxic materials should be stored in secondary containment at all times as a best management practice.
- If possible, store all acutely toxic materials in a cabinet dedicated only for acutely toxic materials. Signs should be posted to indicate their presence and unique hazards.

- The amount of acutely toxic material stored in the lab should be kept at a minimum. Any expired or unnecessary materials must be properly disposed of as hazardous waste.
- All acutely toxic materials should be clearly labeled with the original manufacturer's label, which should have the chemical name, hazard labels, and pictograms. The label should not be defaced in any way.

### 5.7.6 Corrosive Materials Storage

Corrosive materials are defined as substances that cause destruction of living tissue by chemical corrosion at the site of contact and can be either acidic or basic (caustic). The best storage method for corrosive materials is inside of a corrosive storage cabinet or lab cabinet where acids and bases are segregated at all times. Acids must also be segregated from chemicals where a toxic gas would be generated upon contact with an acid (e.g., cyanide or sulfide compounds). Organic acids (e.g., acetic acid, formic acid) must be stored away from oxidizing acids (e.g., nitric acid, perchloric acid), as these types of acids are incompatible with each other. Segregation can be achieved either by physical distance (preferred method) or by secondary containment as shown in Figure 5.6.

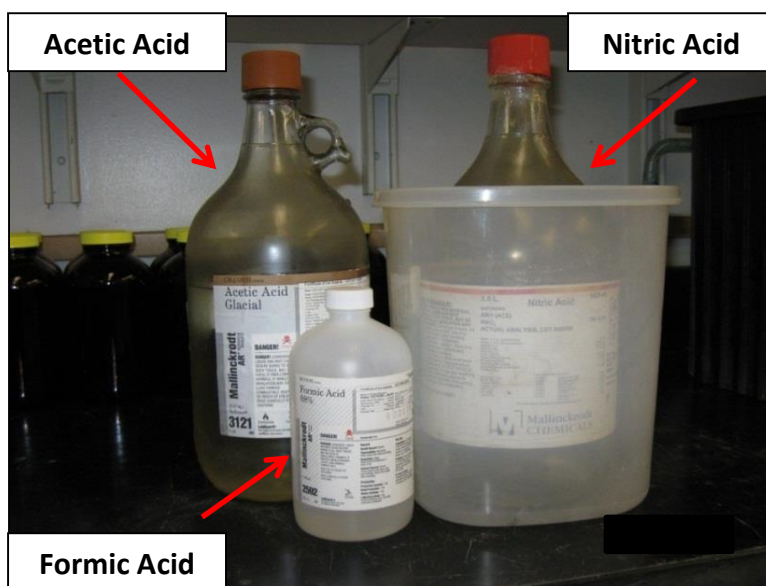


Figure 5.6 – Segregation Using Secondary Containment

### 5.7.7 Oxidizers and Organic Peroxide Storage

Oxidizing materials are defined as substances which, while not necessarily combustible, by yielding oxygen can cause or contribute to the combustion of other material. An organic peroxide is an organic substance which contains the bivalent -O-O- structure and may be

considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. The following guidelines for storing oxidizers and organic peroxides must be followed in all laboratories:

- Oxidizers (e.g., hydrogen peroxide, sodium nitrate) and organic peroxides (e.g., methyl ethyl ketone peroxide, benzoyl peroxide) must be stored in a cool, dry location and kept away from combustible materials such as wood, pressboard, paper, and organic chemicals (e.g., organic solvents and organic acids).
- If possible, store all strong oxidizing agents in a chemical cabinet dedicated only for oxidizers.
- The amount of oxidizers and organic peroxides stored in the lab should be kept at a minimum.
- All material must be clearly labeled; the original manufacturer's label with the chemical name, hazard labels, and pictograms should not be defaced or covered.

### 5.7.8 Refrigerators and Freezers Chemical Storage

A number of general precautions need to be taken when storing chemicals in refrigerators and/or freezers in the laboratory. When working with freezers or refrigerators, the following procedures must be followed:

- Domestic refrigerators or freezers must never be used to store flammable liquids. Flammable liquids are only allowed to be stored in refrigerators or freezers that are designed for flammable materials (most refrigerators are not intended for flammable storage).
- Lab refrigerators or freezers must never be used to store food or beverages for consumption. Lab refrigerators/freezers should be posted with a sign that states "No Food or Drink".
- All chemicals stored in a refrigerator or freezer must be labeled.
- Ensure that the chemicals stored in a refrigerator or freezer is compatible with each other. For example, do not store an oxidizer such as hydrogen peroxide in a refrigerator with organic chemicals.
- There must not be any open chemicals in a refrigerator or freezer. All containers must be completely sealed or capped and safely stored.
- Chemicals should be allowed to warm to room temperature before sealing to prevent pressure buildup.



- Shelves in refrigerators or freezers should all have suitable plastic trays for secondary containment in the refrigerator and freezer compartments. If plastic trays are not available, liquid chemicals should be placed in secondary containers to contain spills.
- Remember that power outages and technology failures can cause internal temperatures to rise, which can impact chemical contents. Be aware of unusual odors, vapors, etc., when opening the refrigerator or freezer.
- An inventory should be posted on the refrigerator door.
- Chemical refrigerator or freezers should be located away from laboratory exits.
- Refrigerators and freezers should be cleaned-out and manually defrosted as necessary.
- When defrosting a freezer, consideration should be taken regarding potential chemical contamination of the water. If the water draining from a defrosted refrigerator may be chemically contaminated, contact REM at (765) 494-0121 for further assistance.

## 5.8 Compressed Gas Cylinder Safety

Compressed gas storage requirements are discussed above in Section 5.7.3. However, there are some additional important safety requirements for use of compressed gases in laboratories detailed below:

- Gas cylinder connections and fittings must be inspected frequently for deterioration.
- Never use a leaking, corroded, or damaged cylinder and never refill a compressed gas cylinder.
- When stopping a leak between the cylinder and regulator, always close the valve before tightening the union nut.
- The regulator must be replaced with a safety cap when the cylinder is not in use.
- The safety cap must be in place when a gas cylinder is moved. For large gas cylinders (>27 inches), an approved gas cylinder cart should be used to move it.
- The cylinder must be strapped to the cart and the protective cap must be in place before moving the cylinder. A cylinder should never be moved or transported without the protective cap. The proper way to move a large gas cylinder is illustrated in Figure 5.7.
- Never dispense from a cylinder if it is on a gas cylinder cart.





**Figure 5.7 – Gas Cylinder Cart**

A few compressed gas cylinders have a shelf-life and can become more hazardous as time goes on. It is extremely important that these cylinders are identified and managed properly. If any time-sensitive gases are found to be past the manufacturer's expiration date, they must be submitted to REM for hazardous waste disposal immediately. The following is a list of time-sensitive compressed gases:

- Hydrogen Fluoride, anhydrous
- Hydrogen Bromide, anhydrous
- Hydrogen Sulfide, anhydrous
- Hydrogen Cyanide, anhydrous
- Hydrogen Chloride, anhydrous

The compressed gases listed above have a shelf-life provided by the manufacturer that must be strictly followed. There have been numerous incidents involving these compounds related to storage past the expiration date. For example, hydrogen fluoride (HF) and hydrogen bromide (HBr) cylinders have a shelf-life of one to two years, depending on the manufacturer. Over time, moisture can slowly enter the cylinder, which initiates corrosion. As the corrosion continues, HF and/or HBr slowly react with the internal metal walls of the cylinder to produce hydrogen. The walls of the cylinder slowly weaken due to the corrosion, while at the same time the internal pressure increases due to the hydrogen generation. Ultimately, these cylinders fail and create extremely dangerous projectiles and a toxic gas release which can be deadly. Figure 5.8 shows a 30-year old HF lecture bottle cylinder that exploded in a Purdue University laboratory in 2011.



**Figure 5.8 – HF Cylinder Incident at Purdue University in 2011**

## 5.9 Cryogenic Liquids Safety

A cryogenic liquid is defined as a liquid with a normal boiling point below  $-150\text{ }^{\circ}\text{C}$  ( $-240\text{ }^{\circ}\text{F}$ ). The most common cryogenic liquid used in a laboratory setting is liquid nitrogen. By definition, all cryogenic liquids are extremely cold. Cryogenic liquids and their vapors can rapidly freeze human tissue and can also pose an asphyxiation hazard if handled in confined spaces. The following precautions should be taken when handling cryogenic liquids:

- Use and store cryogenic liquids in well ventilated areas only.
- Wear appropriate PPE while handling cryogenic liquids. Proper PPE for handling cryogenic liquids includes chemical splash goggles, a face shield, cryogenic-safe gloves, long sleeves, long pants, and closed-toe shoes.
- Cryogenic liquids will vent (boil off) from their storage containers as part of normal operation. Containers are typically of a vacuum jacketed design to minimize heat loss. Excessive venting and/or an isolated ice build-up on the vessel walls may indicate a fault in the vessel's integrity or a problem in the process line. A leaky container should be removed from service and taken to a safe, well-ventilated area immediately.
- All systems components piping, valves, etc., must be designed to withstand extreme temperatures.
- Pressure relief valves must be in place in systems and piping to prevent pressure build up. Any system section that could be valved off while containing cryogenic liquid must

have a pressure relief valve. The pressure relief valve relief ports must be positioned to face toward a safe location.

- Transfer operations involving open cryogenic containers, such as Dewars must be done slowly, while wearing all required PPE. Care must be taken not to contact non-insulated pipes and system components.
- Open transfers will be allowed only in well-ventilated areas.
- Do not use a funnel while transferring cryogenic liquids.
- Use tongs or other similar devices to immerse and remove objects from cryogenic liquids; never immerse any part of your body into a cryogenic liquid.

### 5.10 Nanoparticle Safety

The American Society of Testing and Materials (ASTM) Committee on Nanotechnology has defined a nanoparticle as a particle with lengths in two or three dimensions between 1 and 100 nanometers (nm). Nanoparticles can be composed of many different base materials and may be of different shapes including: nanotubes, nanowires, and crystalline structures such as fullerenes and quantum dots. Nanoparticles present a unique challenge from an occupational health perspective as there is a limited amount of toxicological data currently available for review. However, some studies have shown that existing exposure control technologies have been effective in reducing exposure to nanoparticles. Refer to the Nanoparticle Safety and Health Guidelines for detailed procedures and guidance regarding the safe handling of nanoparticle. (<http://www.purdue.edu/ehps/rem/home/booklets/nanopolicy.pdf>)

### 5.11 Sharps Handling Safety

Sharps are defined as items capable of puncturing, cutting, or abrading the skin such as glass or plastic pipettes, broken glass, test tubes, petri dishes, razor blades, needles, and syringes with needles. Sharps are often contaminated with hazardous chemicals and/or infectious agents, so multiple hazards are often encountered. Employees that routinely work with sharps must be aware of the risk of being punctured or lacerated. It is important for these employees to take precautions and properly handle sharps in order to prevent injury and potential disease transmission. These employees should use appropriate PPE (e.g., puncture-resistant gloves), tools, barrier protection, sharps waste containers, and engineering controls to protect themselves. Refer to the Sharps and Infectious Waste: Handling and Disposal Guidelines for detailed procedures regarding sharps handling and disposal procedures. (<http://www.purdue.edu/ehps/rem/home/booklets/sharps.pdf>)

## 5.12 Equipment, Apparatus, and Instrument Safety

### 5.12.1 Centrifuges

The following safety guidelines should be followed when operating centrifuges:

#### Before centrifugation:

- Centrifuges must be properly installed and operated only by trained personnel. Centrifuges cannot be placed in the hallway of a building; they must remain inside of the laboratory.
- Train each operator on proper operating procedures, review the user manual.
- Use only rotors compatible with the centrifuge. Check the expiration date for ultracentrifuge rotors.
- Check tubes, bottles, and rotors for cracks and deformities before each use.
- Make sure that the rotor, tubes, and spindle are dry and clean.
- Examine O-rings and replace if worn, cracked, or missing.
- Never overfill centrifuge tubes (do not exceed  $\frac{3}{4}$  full).
- Always cap tubes before centrifugation.
- Always balance buckets, tubes, and rotors properly.
- Check that the rotor is seated on the drive correctly, close the lid on the centrifuge, and secure it.
- When using swinging bucket rotors, make sure that all buckets are hooked correctly and move freely.



#### During centrifugation:

- Close lids at all times during operation. Never open a centrifuge until the rotor has stopped.
- Do not exceed safe rotor speed.
- The operator should not leave the centrifuge until full operating speed is attained and the machine appears to be running safely without vibration.
- Stop the centrifuge immediately if an unusual condition (noise or vibration) begins and check load balances.

### After centrifugation:

- Allow the centrifuge to come to a complete stop before opening.
- Wear new pair of outer gloves to remove rotor and samples.
- Check inside of centrifuge for possible spills and leaks, clean centrifuge and rotor thoroughly if necessary.
- Wash hands after removing gloves.

### **5.12.2 Stirring and Mixing Equipment**

Stirring and mixing devices commonly found in laboratories include stirring motors, magnetic stirrers, and shakers. These devices are typically used in lab operations that are performed in a chemical fume hood, and it is important that they be operated in a way that prevents the generation of electrical sparks. Only spark-free induction motors should be used in power stirring and mixing devices or any other rotating equipment used for laboratory operations. Because stirring and mixing devices, especially stirring motors and magnetic stirrers, are often operated for fairly long periods without constant attention, the consequences of stirrer failure, electrical overload or blockage of the motion of the stirring impeller should be considered.



### **5.12.3 Heating Devices**

Laboratories commonly use heating devices such as ovens, hot plates, heating mantles, oil baths, salt baths, sand baths, air baths, hot-tube furnaces, hot-air guns, and microwave ovens. Steam heated devices are generally preferred whenever temperatures of 100 °C or less are required because they do not present shock or spark risks and can be left unattended with assurance that their temperature will never exceed 100 °C. Ensure the supply of water for steam generation is sufficient prior to leaving the reaction for any extended period of time.

A number of general precautions need to be taken when working with heating devices in the laboratory. When working with heating devices, consider the following:

- The actual heating element in any laboratory heating device should be enclosed in such a fashion as to prevent a laboratory worker or any metallic conductor from accidentally touching the wire carrying the electric current.
- If a heating device becomes so worn or damaged that its heating element is exposed, the device should be either discarded or repaired before it is used again.
- The external cases of all variable autotransformers have perforations for cooling by ventilation and, therefore, should be located where water and other chemicals cannot be spilled onto them and where they will not be exposed to flammable liquids or vapors.
- Fail-safe devices can prevent fires or explosions that may arise if the temperature of a reaction increases significantly because of a change in line voltage, the accidental loss of reaction solvent, or loss of cooling. Some devices will turn off the electric power if the temperature of the heating device exceeds some preset limit or if the flow of cooling water through a condenser is stopped owing to the loss of water pressure or loosening of the water supply hose to a condenser.

#### 5.12.4 Distillation and Solvent Purification Systems

The process of thermal solvent distillation is inherently dangerous. If not handled properly, fire, explosion, and/or personnel exposure can result. A few common chemicals distilled in laboratories include tetrahydrofuran, methylene chloride, diethyl ether, toluene, dimethylformamide, benzene, and hexanes. The guidelines below should be followed while thermal distillation of organic solvents is conducted in the lab:



- The thermal solvent distillation system should be installed inside of a chemical fume hood if possible.
- Ensure that all heat generating equipment has a shut-off device installed.
- Ensure that all water connections on the condenser are clamped securely.
- Inspect all glassware for defects before setting them up in the experiment.
- Keep all air and water-sensitive drying agents under inert atmosphere. Make consistent efforts to not store or use other flammable or hazardous chemicals inside the fume hood where distillation is taking place.

### 5.12.5 Laboratory Glassware

Broken laboratory glassware is dangerous. Glassware-related injuries ranging from small cuts to multiple stitches and eye damage are common to lab workers. In order to reduce the risk of accidents, the following guidelines should be followed:

- Temperature changes can shatter any laboratory glassware. Never flash-cool glassware with cold water, especially after autoclaving or exposure to any high temperatures.
- Only round-bottomed or thick-walled (e.g., Pyrex) evacuated reaction vessels specifically designed for operations at reduced pressure should be used.
- Inspect glassware for any small imperfections before using. Sometimes a hairline crack may be present. Tap the glassware with a pen and listen to the tone to tell if there is a defect. A ringing tone indicates the glassware is fine, while a dull “thud” indicates there is a flaw present.
- Don not keep cracked glassware. If the bottom of a graduated cylinder is chipped or broken, properly dispose of it.
- Always wear appropriate PPE when working with glassware and varying temperatures. Always wear safety glasses.



### 5.12.6 High Pressure Systems

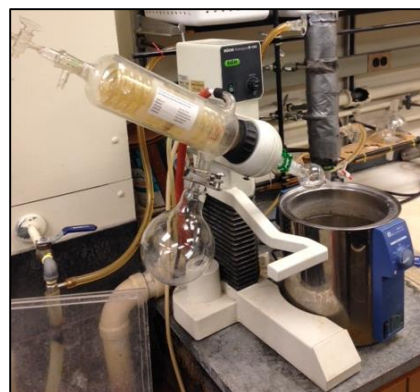
Working with high pressure systems in a laboratory can result in over-pressurization, explosion, and the possible hazards of flying glass, chemical exposure, and fire. All high pressure systems must be set up and operated with careful consideration of potential risks. The following procedures should be followed when working with high pressure systems in the laboratory:

- High-pressure operations should be performed only in pressure vessels appropriately selected for the operation, properly labeled and installed, and protected by pressure-relief control devices.
- Vessels, connecting hoses, and any apparatus must be strong enough to withstand the stresses encountered at the intended operating temperatures and pressures and must not corrode or otherwise react when in contact with the materials it contains.
- All pressure equipment should be visually inspected before each use.

### 5.12.7 Vacuum Systems

Vacuum work can result in an implosion and the possible hazards of flying glass, splattering chemicals, and fire. All vacuum operations must be set up and operated with careful consideration of the potential risks. The following guidelines should be followed when using vacuum apparatus in the laboratory:

- Do not allow water, solvents, or corrosive gases to be drawn into vacuum systems. Protect pumps with cold traps and vent their exhaust into an exhaust hood.
- Assemble vacuum apparatus in a manner that avoids strain, particularly to the neck of the flask.
- Avoid putting pressure on a vacuum line to prevent stopcocks from popping out or glass apparatus from exploding.
- Place vacuum apparatus in such a way that the possibility of being accidentally hit is minimized. If necessary, place transparent plastic around it to prevent injury from flying glass in case of an explosion.
- When using a rotary evaporator, the glass components of the rotary evaporator should be made of Pyrex or similar glass. Glass vessels should be completely enclosed in a shield to guard against flying glass should the components implode. Increase in rotation speed and application of vacuum to the flask whose solvent is to be evaporated should be gradual.
- When using a vacuum source, it is important to place a trap between the experimental apparatus and the vacuum source. The vacuum trap protects the pump and the piping from the potentially damaging effects of the material, protects people who must work on the vacuum lines or system, and prevents vapors and related odors from being emitted back into the laboratory or system exhaust. The following vacuum trapping guidelines should be followed:
  - Make sure the flask is properly clamped and secured.
  - Make sure the vacuum hose is connected to the vacuum line, not the gas line.
  - To prevent contamination, all lines leading from experimental apparatus to the vacuum source should be equipped with filtration or other trapping device as appropriate.





- For particulates, use filtration capable of efficiently trapping the particles in the size range being generated.
- For most aqueous or non-volatile liquids, a filter flask at room temperature is adequate to prevent liquids from getting to the vacuum source.
- For solvents and other volatile liquids, use a cold trap of sufficient size and cold enough to condense vapors generated, followed by a filter flask capable of collecting fluid that could be aspirated out of the cold trap.
- For highly reactive, corrosive, or toxic gases, use a sorbent canister or scrubbing device capable of trapping the gas.

### 5.13 Research Samples and Chemicals Developed in the Lab

Research samples and chemicals developed in the lab (samples) must be managed responsibly. Samples often accumulate in labs for years and are difficult to identify and dispose of and can create unsafe and non-compliant conditions if not managed properly. The following requirements apply to samples developed in the laboratory:

- All samples must be kept closed except when in use. Storage in beakers or flasks should be temporary. If temporarily storing samples in beakers or flasks, a cork, Parafilm<sup>®</sup>, or some other closure device must be used.
- All samples must be labeled with the chemical name, date the sample was developed/received, and the name of generator. Chemical structure or a labeling system that is only known to lab personnel is not acceptable as the only means of labeling samples. Abbreviations can be used as a labeling system as long as an up-to-date legend is posted in the lab.
- Samples should be disposed of within 6 months unless actively being used for analysis. Stockpiling unusable samples is not an acceptable practice. All samples that are no longer necessary must be properly disposed of in a timely manner using REM's hazardous waste program.
- Samples must be stored according to the primary hazard class; this should be done to the best of your ability by considering the properties that are known or assumed.
- If the hazard(s) of a sample are unknown, the Laboratory Supervisor must attempt to determine whether it is hazardous or not. Assume all samples are toxic unless otherwise



demonstrated. This can be accomplished by literature review or reviewing the hazards of other similar compounds. At a minimum, the Laboratory Supervisor should be able to determine if a chemical is flammable, corrosive, oxidant, or reactive. Call REM at (765) (765) 494-0121 for assistance with identifying the hazards of samples.

- If samples are consolidated for storage (e.g., vial boxes), it is not always necessary to label every sample container. For example, a box containing sample vials which are all in the same hazard class (e.g., miscellaneous pharmaceutical compounds considered to be toxic) can have one label on the outside of the box stating “Miscellaneous Toxic Pharmaceutical Compounds” or a similar description. A label such as the one shown in Figure 5.9 can be used to identify consolidated samples, and should only be used on a temporary basis. This type of information communicates the hazards to emergency responders, as well as gives REM the information necessary for proper disposal.
- If the chemical substance is produced for another user outside of the lab, the Laboratory Supervisor must comply with the OSHA Hazard Communication Standard including the requirements for preparing a SDS and properly labeling the sample.

|   |           |          |           |
|---|-----------|----------|-----------|
| <b>Chemical Description:</b>                  |           |          |           |
| <u>Miscellaneous Pharmaceutical Compounds</u> |           |          |           |
| <b>Employee Name:</b>                         |           |          |           |
| <u>Purdue Pete</u>                            |           |          |           |
| <b>Date:</b>                                  |           |          |           |
| <u>10/10/2013</u>                             |           |          |           |
| <b>Circle the hazard(s) that apply:</b>       |           |          |           |
| Flammable                                     | Reactive  | Oxidizer | Corrosive |
| <u>Toxic</u>                                  | Explosive | Irritant | Non-Haz   |
| Other: _____                                  |           |          |           |

Figure 5.9 – Example Temporary Sample Container Label

## 5.14 Transporting Hazardous Chemicals

Transporting chemicals is a potentially hazardous process that must be done properly to avoid accidents and potential injuries. The following subsections discuss how to properly ship chemical off campus using a shipping company, how to transport chemicals on campus using a Purdue-owned vehicle, and how to safely move chemicals by foot across campus.

### 5.14.1 Shipping Hazardous Chemicals off Campus

Shipping chemicals, research samples, or other similar materials off campus is potentially regulated by the Department of Transportation (DOT) and/or other regulatory agencies. Chemicals regulated for shipping require very specific types of packaging, labeling, and documentation and must be prepared by trained personnel. REM makes the determination on whether a chemical is classified as hazardous for transportation purposes. Unless the researcher is DOT trained, they are not authorized to make this determination. Shipments that are not prepared by trained personnel can result in delays, loss of research samples, and potential regulatory fines. REM can provide assistance by either providing shipment services, or if necessary, training personnel on the proper shipping procedures. More information about shipping chemicals can be found on the REM website.

<http://www.purdue.edu/ehps/rem/hmm/shiphm.htm>

As previously stated, REM prepares all regulated chemicals for shipment according to DOT requirements. However, laboratory personnel prepare the inner container (e.g., vial, jar) and provide it to REM for shipment. When selecting an inner container to be given to REM for an off-campus hazardous materials shipment, the following guidelines must be followed:

- The chemical must be compatible with the container. For example, corrosive chemicals must not be placed in metal containers; hydrofluoric acid in any concentration must not be placed in glass containers.
- Chemical permeability should be considered when selecting a plastic container, especially for organic solvents. The container must be able to effectively contain the chemical during transportation under normal conditions.
- The container must have an appropriate lid that is able to close and seal, meaning the container will not leak during transportation under normal conditions. Any containers that do not properly seal (e.g., beaker, flask, test tube) will not be shipped off campus by REM.

### 5.14.2 Transporting Chemicals on Campus via Purdue Vehicle

Purdue University is a state agency and therefore is exempt from Department of Transportation (DOT) hazardous materials regulations. However, the “intent” of the DOT regulations is still required when transporting chemicals on campus using a motor vehicle. This essentially means that all chemical containers must be properly packaged, labeled, and segregated according to hazard class. Do not attempt to move large volumes (e.g., greater than 5 gallons in total volume) of chemicals across campus. If a large volume of chemicals needs to be moved across campus, such as an entire lab move, contact REM (765) 494-0121

for further assistance. The following procedures must be followed in order to properly and legally transport chemicals across campus:

- Only Purdue-owned vehicles are permitted to be used to transport chemicals. For liability and insurance purposes, no personal vehicles should ever be used to transport hazardous chemicals.
- The hazardous materials cannot be stored/transported in the same compartment that the passengers are in; must be placed either in the trunk of a car or bed of truck depending on the specific hazards and quantity, contact REM for further instruction.
- Ensure that each container has an appropriate, tight fitting lid. The lid should have the ability to contain the contents of the container even if it becomes inverted during transport. Examples of inappropriate lids include cracked caps, loosely fitting rubber stoppers, or Parafilm®.
- Chemicals should be segregated according to the primary hazard class. For example, do not place an oxidizer such as ammonium nitrate in the same container as an organic solvent such as acetone.
- All containers should be packaged upright.
- Chemical containers should be placed in some type of outer packing such as a box, bin or bucket. Containers should remain securely packaged during loading, transport, and unloading. Glass to glass contact should be avoided. Bubble wrap, newspaper, and vermiculite are good examples of packaging material that will prevent glass to glass contact.
- The outer containers should remain tightly secured during transport. Measures should be taken to avoid movement of the outer containers. For example, the containers should be secured using a strap or an empty box can be used to fill the gap between the last box and the sidewall of the vehicle.
- The outer container must be labeled in a manner that identifies the contents (e.g. corrosives, flammables).
- Transport with two or more people if possible.
- Be prepared for unseen accidents. At least one person should be knowledgeable of the materials being transported. An inventory with an estimated volume or weight per hazard should be recorded and available during transport (e.g., 5 gallons of flammable liquid and 10 pounds of toxic solids).
- Prepare a spill kit prior to transport. Material such as appropriate PPE, absorbent material, and an empty bucket is sufficient for most small spills.
- Carry a cell phone and know who to call in the event of an emergency. The Purdue Fire Department will respond to on-campus emergencies. Dial 911 from a Purdue phone or (765) 494-8221 from a cell phone to contact Purdue Police dispatch.

### 5.14.3 Transporting Chemicals on Campus via Foot

Transporting small volumes of chemicals across campus via foot (e.g., from two neighboring campus buildings) is acceptable as long as it is done properly. Do not attempt to move large volumes (e.g., greater than 5 gallons in total volume) of chemicals across campus via foot. If a large volume of chemicals needs to be moved, such as an entire lab move, contact REM (765) 494-0121 for further assistance. The following procedures must be followed when moving chemicals on campus by way of foot:

- PPE must be worn when handling potentially contaminated surfaces. During the time which the chemicals are moved on campus via foot, PPE may not be necessary or even appropriate (e.g., employees should not wear chemical-resistant gloves in public areas). However, appropriate PPE and spill containment equipment should be brought along in the event of a spill or incident.
- Purdue Stores' stock room personnel shall not dispense or sell chemicals in breakable containers of any size unless the customer has an approved transport container in which to place the chemical for transporting before leaving the Stock Room. Chemical requisitioners may purchase a transport container from Purdue Stores. Approved transport container means a commercially available bottle carrier made of rubber, metal, or plastic with carrying handle(s) which is large enough to hold the contents of the container if broken in transit. Carrier lids or covers are recommended, but not required. Rubber or plastic should be used for acids/alkalis; and metal, rubber, or plastic for organic solvents. An example of a bottle carrier is illustrated in Figure 5.10.
- Laboratory carts used to transport chemicals from one area to another shall be stable and in good condition. Transport only a quantity which can be handled easily. Plan the route ahead of time so as to avoid all steps or stairs.
- Freight elevators, not passenger elevators, should be used to transport hazardous chemicals whenever possible. The individual transporting the hazardous chemicals should operate the elevator alone if possible. Avoid getting on an elevator when a person is transporting hazardous chemicals.



**Figure 5.10 – Chemical Bottle Carrier**

## 5.15 Laboratory Security

All laboratory personnel have a responsibility to protect university property from misuse and theft of hazardous materials, particularly those that could threaten human health. At a minimum, the following security measures should be employed in all campus laboratories:

- The laboratory door should remain locked when not occupied.
- Always feel free to question anyone that enters the lab that you do not know and ask to see identification if necessary.
- If you see anything suspicious or someone displays suspicious behavior, immediately report it to the Purdue Police Department by dialing 911 (emergency) or (765) 494-8221 (non-emergency).
- Any sensitive information or particularly hazardous chemicals should not be stored out in the open where anyone can readily have access to them. These types of materials should be stored in a secure location and lab personnel should always be present when these materials are in use.

## 5.16 Laboratory Self-Inspections

REM performs laboratory inspections for various purposes (e.g., routine building safety and compliance inspections). However, the Laboratory Supervisor or a qualified designee should also inspect the laboratory for compliance with the requirements of the CHP at a minimum on an annual basis. Lab personnel have a much greater understanding of the unique hazards and issues that are encountered in their individual lab than REM does. The goal of these self-inspections is to identify and correct unsafe and non-compliant conditions that could potentially result in an injury to lab personnel or a fine from a regulatory agency (e.g., open hazardous waste container). All deficiencies found during the inspection should be reviewed and corrected. The following elements should be performed during these inspections:

- Housekeeping practices should be reviewed. Chemicals should be stored appropriately and labeled. Evidence of spills and/or chemical contamination should be cleaned. All glassware and equipment should be stored appropriately, etc.
- Hazard assessments should be updated if process changes have occurred. For example, the lab is now performing organic synthesis and working with organometallic compounds.
- Training records should be updated and documented if new lab personnel have not yet been trained or if any processes have changed.
- Excess or outdated chemicals should be properly disposed of by REM.

- Safety supplies such as PPE and spill containment equipment should be replenished if necessary.

A recommended template to use during laboratory self-inspections is the ISP Self-Audit Checklist, which can be found on the REM website.

(<http://www.purdue.edu/ehps/rem/home/forms/ispcheck.pdf>)

## 5.17 Laboratory Ergonomics

Many tasks in laboratories require repetitive motions which may lead to cumulative trauma injuries of the body, these effects can be long term. Tasks like pipetting, weighing multiple samples, standing at the bench or hood and using microscopes for long periods of time can cause physical stress. Even time compiling data at a computer poses potential physical problems. Ergonomics is the study of interaction of the human body with the work environment. Ergonomics strives to fit the job to the body through proper body positioning, posture, movement, tools, workplace layout and design. Parts of the body commonly affected by poor ergonomics include: neck, shoulders, back, hands, wrists, elbows, legs, and feet.

REM has resources available to improve ergonomic conditions and help reduce cumulative trauma injuries to laboratory workers. Often simple adjustments are all that is required to improve conditions. Refer to the REM website for detailed information regarding REM's laboratory ergonomics program. (<http://www.purdue.edu/ehps/rem/safety/ergo.htm>)

## 5.18 Laboratory Electrical Safety

### 5.18.1 Training

Laboratory employees shall be trained to understand the specific hazards associated with electrical energy. See the written Electrical Safety Program for more detailed information.

(<http://www.purdue.edu/ehps/rem/home/booklets/elsp.pdf>)

Employees who need access to operate circuit breakers and fused switches in electrical panels may require additional training to be designated by their supervisor as qualified for the task.

### 5.18.2 Portable Electrical Equipment and Extension Cords

The following requirements apply to the use of cord-and-plug-connected equipment and flexible cord sets (extension cords):

- Extension cords may only be used to provide temporary power and must be used with Ground Fault Circuit Interrupter (GFCI) protection during maintenance and construction activities and in damp or wet locations.
- Portable cord and plug connected equipment and extension cords must be visually inspected before use for external defects such as loose parts, deformed and missing pins, or damage to outer jacket or insulation, and for possible internal damage such as pinched or crushed outer jacket. Any defective cord or cord-and-plug-connected equipment must be removed from service and no person may use it until it is repaired and tested to ensure it is safe for use.
- Extension cords must be of the three-wire type. Extension cords and flexible cords must be designed for hard or extra hard usage. The rating or approval must be visible.
- Portable equipment must be handled in a manner that will not cause damage. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment.
- Extension cords must be protected from damage. Sharp corners and projections must be avoided. Flexible cords may not be run through windows or doors unless protected from damage, and then only on a temporary basis. Flexible cords may not be run above ceilings or inside or through walls, ceilings or floors, and may not be fastened with staples or otherwise hung in such a fashion as to damage the outer jacket or insulation.
- Extension cords used with grounding type equipment must contain an equipment-grounding conductor; the cord must accept a three-prong, or grounded, plug. Operating equipment with extension cords without a grounding plug is prohibited.
- Attachment plugs and receptacles may not be connected or altered in any way that would interrupt the continuity of the equipment grounding conductor. Additionally, these devices may not be altered to allow the grounding pole to be inserted into current connector slots. Clipping the grounding prong from an electrical plug is prohibited.
- Flexible cords may only be plugged into grounded receptacles. Adapters that interrupt the continuity of the equipment grounding connection may not be used.
- All portable electric equipment and flexible cords used in highly conductive work locations, such as those with water or other conductive liquids, or in places where employees are likely to contact water or conductive liquids, must be approved for those locations.
- Employee's hands must be dry when plugging and unplugging flexible cords and cord and plug connected equipment if energized equipment is involved.



- If the connection could provide a conducting path to the employee's hands (e.g. if a cord connector is wet from being immersed in water), the energized plug and receptacle connections must be handled only with insulating protective equipment.
- Lamps for general illumination must be protected from breakage, and metal shell sockets must be grounded.
- Temporary lights must not be suspended by their cords unless they have been designed for this purpose.
- Extension cords are considered to be temporary wiring, and must also comply with the section on "Requirements for Temporary Wiring" in this program.

### 5.18.3 Temporary Wiring Requirements

Temporary electrical power and lighting installations 600 volts or less, including flexible cords, cables and extension cords, may only be used during and for renovation, maintenance, repair, or experimental work. The following additional requirements apply:

- Ground-fault protection (e.g. GFCI) must be provided on all temporary-wiring circuits, including extension cords, used for construction or maintenance activities.
- In general, all equipment and tools connected by cord and plug must be grounded. Listed or labeled double insulated tools and appliances need not be grounded.
- Receptacles must be of the grounding type.
- Flexible cords and cables must be of an approved type and suitable for the location and intended use. They may not be used as a substitute for the fixed wiring, where run through holes in walls, ceilings or floors, where run through doorways, windows or similar openings, where attached to building surfaces, or where concealed behind building walls, ceilings, floors, rugs or carpeting .
- Suitable disconnecting switches or plug connects must be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.
- Lamps for general illumination must be protected from accidental contact or damage, either by elevating the fixture above 8 feet above the floor or other working surface or by providing a suitable guard. Hand lamps supplied by flexible cord must be equipped with a handle of molded composition or other approved material and must be equipped with a substantial bulb guard.
- Flexible cords and cables must be protected from accidental damage. Sharp corners and projections are to be avoided. Flexible cords and cables must be protected from damage when they pass through doorways or other pinch points.

#### 5.18.4 Wet or Damp Locations

Work in wet or damp work locations (i.e., areas surrounded or near water or other liquids) should not be performed unless it is absolutely critical. Electrical work should be postponed until the liquid can be cleaned up. The following special precautions must be incorporated while performing work in damp locations:

- Only use electrical cords that have GFCIs;
- Place a dry barrier over any wet or damp work surface;
- Remove standing water before beginning work. Work is prohibited in areas where there is standing water;
- Do not use electrical extension cords in wet or damp locations; and
- Keep electrical cords away from standing water.

## Chapter 6: Laboratory PPE Policy

### 6.1 Purpose

The purpose of this Laboratory Personal Protective Equipment (PPE) Policy is to ensure that all Purdue lab employees are aware of the PPE requirements and procedures to adequately protect themselves against chemical, radiological, biological, or mechanical hazards. This policy has been prepared in accordance with the requirements of the OSHA PPE regulations (29 CFR 1910.132 - 29 CFR 1910.140, 29 CFR 1910.95). As briefly discussed in Chapter 4 of the CHP, PPE should never be used in place of engineering or administrative controls.

### 6.2 Scope

This Laboratory PPE Policy applies to all personnel that work with or around hazardous chemicals or other safety and health hazards in laboratory setting. This policy is a part of the larger, all-encompassing Purdue PPE Policy that applies to all areas (not just laboratories) of the West Lafayette Campus, regional campuses, research farms, agricultural centers and related facilities and operations. This Laboratory PPE Policy does not cover all potential hazards (e.g., confined space entry, welding operations, high voltage, etc.) in all operations or settings. If a laboratory encounters hazards not covered in this Laboratory PPE Policy, then refer to the Purdue University personal Protective Equipment (PPE) Policy for more information or contact REM at (765) 494-6731 for assistance.

<http://www.purdue.edu/ehrs/rem/home/booklets/PPEPolicy.pdf>

### 6.3 Hazard Assessment

The hazard assessment is a process of identifying the hazards associated with a defined task, and prescribing PPE along with other relevant protection measures that must be employed to minimize the risk from the identified hazards. Hazard assessments are performed by completing a certification of hazard assessment, which is a written document detailing the hazard assessment process for defined tasks. The Laboratory Supervisor is responsible for ensuring that hazard assessments are performed and the certification(s) is written, signed, dated, and readily available or posted in the lab. The Laboratory Supervisor is also responsible for ensuring that all lab personnel receive documented training on applicable hazard assessments. The certification of hazard assessment should be reviewed at least annually and updated any time a process is modified or when a new task which presents a hazard is introduced into the lab.

Hazard assessments can be organized using three formats: by individual task (e.g., pipetting hazardous liquids), by location (e.g., Chemistry Laboratory Room 1250), or by job title (e.g., Chemistry Lab Technician). Any of these formats is acceptable and often will be used in conjunction with each other to provide the safest laboratory work environment possible for employees. The following subsections describe each hazard assessment format in more detail.

### 6.3.1 Task Evaluation Hazard Assessment

Task evaluation hazard assessments should be conducted for specific tasks such as preparing dilute hydrochloric acid solutions or an ozonolysis reaction and workup. These types of hazard assessments should be written in a very detailed manner. The following steps that should be taken to perform a task evaluation hazard assessment:

- Describe the task.
- List the potential hazards associated with each body part (e.g., Eyes: Chemical Splash).
- Determine the appropriate PPE requirements for each hazard (e.g., Eyes: Safety Goggles).
- List other control measures required such as engineering and administrative controls (e.g., always prepare solutions in the chemical fume hood).

See REM's Forms webpage for the task evaluation hazard assessment template.

(<http://www.purdue.edu/ehps/rem/home/form.htm#ppe>)

### 6.3.2 Location Evaluation Hazard Assessment

Location evaluation hazard assessments should be conducted for specific laboratories. These types of hazard assessments should be written in a comprehensive manner that includes the majority of hazards present in a specific location (e.g., flammable and corrosive liquids). This type of hazard assessment is most commonly used in laboratories and should be posted in a location within the lab where it is easily accessed by personnel (e.g., posted near the front door of the lab). If employees perform specific tasks not covered by the laboratory hazard assessment, then it will be necessary to perform a task evaluation assessment that does address the specific hazards of that task. The following describes the steps that should be taken to perform a task evaluation hazard assessment:

- Identify the hazards of the lab (e.g., flammable/corrosive/oxidant/toxic liquids).
- List each task where the hazard is present.
- Determine PPE requirements for each task.

- List other control measures required such as engineering and administrative controls (e.g., all work with hazardous chemicals should be conducted in a chemical fume hood).

See REM's Forms webpage for the location evaluation hazard assessment template.

(<http://www.purdue.edu/ehps/rem/home/form.htm#ppe>)

### 6.3.3 Job Title Evaluation Hazard Assessment

Job title evaluation hazard assessments should be conducted for specific positions. These types of hazard assessments should be written in a comprehensive manner that includes the majority of hazards that a specific job position (e.g., Animal Care Technician) routinely encounters during the normal course of work. This type of hazard assessment is commonly used for positions where the hazards encountered do not frequently change. If the employee encounters a hazard that is not covered by the job title evaluation hazard assessment, then it will be necessary to perform another type of hazard assessment such as the task evaluation hazard assessment that does address the specific hazards of that task. The following describes the steps that should be taken to perform a task evaluation hazard assessment:

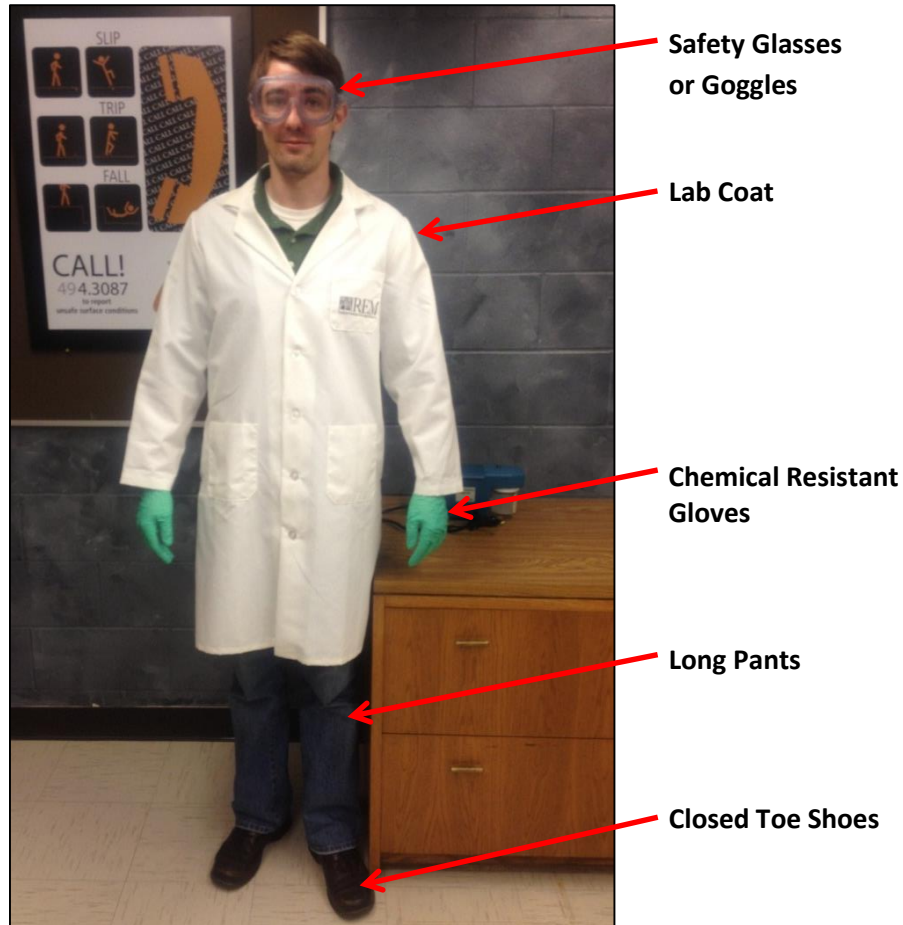
- Identify hazards that the position title may encounter while performing normal duties (e.g., animal bites while working with mice).
- List each task where the hazard is present.
- Determine the PPE requirements for each task.
- List other control measures required such as engineering and administrative controls.

See the REM's Forms webpage for the job title evaluation hazard assessment template.

(<http://www.purdue.edu/ehps/rem/home/form.htm#ppe>)

## 6.4 Minimum PPE Requirements for Laboratories

This section details the minimum PPE requirements for all laboratories using hazardous chemicals. These requirements do not apply to labs that involve solely mechanical, computer, laser or other non-ionizing radiation, or electrical operations. The requirements listed do not cover all operations in all laboratories. Some operations and procedures may warrant further PPE, as indicated by the SDS, the SOP for the chemical(s) being used, facility policies, or regulatory requirements. Figure 6.1 illustrates the minimum PPE required when using hazardous chemicals in a laboratory.



**Figure 6.1 – Appropriate PPE for the Laboratory**

#### **6.4.1 Head Protection**

If there is a serious risk of chemical splash to the head, a chemical-resistant hoodie must be worn. Each affected employee must wear protective helmets when working in areas where there is a potential for injury to the head from falling objects or “bump” hazards.

#### **6.4.2 Hearing Protection**

Hearing protection is not typically required in laboratory settings. However, if the lab seems excessively noisy (e.g., operating equipment that is loud, air handling unit is loud) and it is difficult to communicate with co-workers while in the lab, contact REM (765) 494-6371 for a noise level evaluation.

### 6.4.3 Respiratory Protection

The use of respirators in the laboratory setting is not typically necessary since all work involving hazardous materials must be conducted in a chemical fume hood whenever possible. When ventilation is not adequate to provide protection against an inhalation hazard, respiratory protective equipment may be necessary. There is a variety of respiratory protective equipment available for use, but no one device will provide protection against all possible hazards. Respirator selection is based on the chemical and process hazard, and the protection factors required. Respirators are not to be used except in conjunction REM's "Respiratory Protection Program". This program includes a review of the process to ensure that proper equipment is selected for the job, training of all respiratory protective equipment users concerning the methods for proper use and care of such equipment, fitting of respirator users when required, and medical surveillance of respirator users when required. Contact REM at (765) 494-6371 with questions about the Respiratory Protection Program or visit the REM website.

<http://www.purdue.edu/ehps/rem/home/booklets/rpp.pdf>

### 6.4.4 Eye and Face Protection

Each affected employee must use appropriate eye and face protection equipment when exposed to hazards from chemical splash, flying debris, or other exposures that may occur in the laboratory. Safety glasses must be worn at all times by all individuals that are occupying the laboratory area. Splash-proof safety goggles and/or a face shield may be more appropriate depending on the type of work being performed (e.g., transferring liquids outside of a chemical fume hood). All eye protection equipment must be American National Standards Institute (ANSI) approved and appropriate for the work being done. Eye and face protection may not be required in the lab if the employee is sitting at a workstation or desk that is away from chemical processes (e.g., working at a desktop computer, having a lab meeting at a table not adjacent to hazardous operations).



### 6.4.5 Hand Protection

Each affected employee must wear appropriate hand protection when the hands may be exposed to skin contact of hazardous chemicals, cuts, abrasions, punctures, or harmful temperature extremes. Chemical-resistant gloves must be worn while handling any hazardous chemical container; regardless of whether the container is



open or closed (it should be assumed that all chemical containers are contaminated). When selecting appropriate gloves, it is important to evaluate the effectiveness of the glove type to the specific hazardous chemical being handled. Some gloves are more suitable for certain chemicals than others. The SDS for the specific chemical being handled and the glove manufacturer's glove chart should be consulted to select the most appropriate glove. Do not purchase gloves from a manufacturer that does not provide an adequate glove chart. It is recommended that each lab purchase a general purpose disposable nitrile glove (nitrile gloves are typically more versatile and provide resistance to a wider range of chemicals than latex gloves do) with a minimum of a 4 mil thickness that is suitable for general chemical handling. When handling chemicals or equipment with harmful temperature extremes such as liquid nitrogen or autoclaves, appropriate protection such as cryogenic gloves or heat-resistant gloves must be worn.

The volume of hazardous chemical being handled should be considered as well. For example, if working with a small volume of a sodium hydroxide solution, disposable chemical-resistant gloves provide adequate protection. But if working with a large volume of sodium hydroxide as with a base bath for instance, a more durable and thick glove such as a butyl rubber should be selected to provide adequate protection.



Chemical-resistant gloves must not be worn outside of the laboratory (e.g., hallways, elevators, offices) to avoid contamination of public areas. Gloves should also be removed prior to handling any equipment that could likely result in cross-contamination (e.g., water fountains, phones, computer work stations). Disposable gloves must never be reused.

#### 6.4.6 Body Protection

Each affected employee must wear protective clothing to protect the body from recognized hazards. All unprotected skin surfaces that are at risk of injury should be covered. Full length pants or a full-length skirt must be worn at all times by all individuals that are occupying the laboratory area; shorts are not permitted. Lab coats, coveralls, aprons, or protective suits are required to be worn while working on, or adjacent to, all procedures using hazardous chemicals (using means that the chemical bottle is open and the chemical is being poured, transferred, pipetted, etc.). Lab coats must be appropriately sized for the individual and be fastened (snap buttons are recommended) to their full length. Lab coat sleeves must be of a sufficient length to prevent skin exposure while wearing gloves. Flame resistant lab coats must be worn when





using pyrophoric materials or flammable liquids greater than 1 liter in volume. It is also recommended that 100% cotton (or other non-synthetic material) clothing be worn underneath the flame resistant lab coat to minimize injury in the case of a fire emergency.

Lab coats should not be worn outside of the lab unless the individual is traveling directly to an adjacent lab work area. Lab coats should not be worn in common areas such as break rooms, offices, or restrooms. Each department is responsible for providing laundry services as needed to maintain the hygiene of laboratory coats. They may not be cleaned by staff members at private residences or public laundry facilities. Alternatives to laundering lab coats include routinely purchasing new lab coats for employees to replace contaminated lab coats, hiring a professional garment laundering service, or using disposable lab coats. Departments can also choose to purchase a washer and dryer and launder their own lab coats.

#### 6.4.7 Foot Protection

Closed toe shoes must be worn at all times when in the laboratory; open toe shoes and/or sandals are not permitted in any circumstance. Each affected employee must wear protective footwear when working in areas where there is a high-risk of objects falling on or rolling across the foot, piercing the sole, and where the feet are exposed to electrical or chemical hazards. If there is a high risk of chemical contamination to the foot (e.g., cleaning up a chemical spill on the floor), then chemical-resistant booties may need to worn as well.



### 6.5 Minimum PPE Requirements for Support Staff and Visitors

Support staff (e.g., custodians, maintenance workers) and visitors often must enter laboratories to perform routine tasks such as maintenance or take a tour of the lab. These individuals are present in the laboratory, but are not performing work with or directly adjacent to any work with hazardous chemicals. To be present in the laboratory, the minimum PPE requirements include safety glasses, long pants, and closed toe shoe. If additional PPE is required or if other unique safety requirements must be followed, it is the lab personnel's responsibility to notify support staff and/or visitors of the additional requirements.

## 6.6 PPE Training Requirements

Laboratory Supervisors must ensure that all employees receive PPE training before any work with hazardous materials occurs. This training must be documented using the Certification of Training form (Appendix B of the Purdue University Personal Protective Equipment (PPE) Policy: <http://www.purdue.edu/ehps/rem/home/booklets/PPEPolicy.pdf>) or access it directly from <http://www.purdue.edu/ehps/rem/home/forms/CertT.pdf>. Each lab employee must be trained to know at least the following:

- When PPE is necessary;
- What PPE is necessary;
- How to properly don, doff, adjust, and wear PPE;
- The limitations of the PPE; and
- The proper care, maintenance, and useful life of PPE.

Each affected employee must demonstrate an understanding of the training provided and the ability to use the PPE properly before performing any work requiring the use of PPE. When the Laboratory Supervisor has reason to believe that an affected employee who has already been trained does not have the understanding and skill required (e.g., employee is seen handling hazardous materials without wearing proper PPE), then the Laboratory Supervisor must ensure the employee is retrained.

## 6.7 Injuries, Illnesses, and Medical Examinations

Employees must notify their Laboratory Supervisor of all injuries and illnesses regardless of the magnitude. The Laboratory Supervisor must ensure that a First Report of Injury form is completed. Employees should report to a Purdue approved occupational medical provider (<http://www.purdue.edu/hr/Benefits/wcimmediatecare.html#treatmentFacilities>) if medical attention is required (Note: The Purdue University Student Hospital is not an approved occupational medical provider). If the injury is serious and presents an emergency situation, dial 911 and emergency responders (Purdue Fire Department if located on the West Lafayette Campus) will respond and transport the patient to a local hospital emergency room. For more information regarding the First Report of Injury reporting process, visit the REM webpage (<http://www.purdue.edu/ehps/rem/injury/froi.htm>).

Departments must provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory;
- Where 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; and
- 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 examination. All medical examinations must be performed by or under the direct supervision of a licensed medical care provider and must be provided without cost to the employee.

## Chapter 7: Hazardous Waste Management

### 7.1 Introduction

Hazardous waste is generally defined as waste that is dangerous or potentially harmful to human health or the environment. Hazardous waste regulations are strictly enforced by both the Environmental Protection Agency (EPA) and the Indiana Department of Environmental Management. The Laboratory Supervisor is responsible for managing the hazardous waste program in a safe and compliant manner. No chemical waste should be poured down the drain or discarded in the trash unless it is certain that doing so does not violate hazardous waste regulations or the West Lafayette wastewater treatment plant's requirements (see section 7.7 of this chapter for information and guidance for acceptable sink disposal practices).

Hazardous wastes can be liquid, solid, gas, or sludge. They can be discarded chemicals or mixtures generated from research and teaching operations, commercial products (e.g., cleaning fluids or pesticides), or by-products of manufacturing processes. All hazardous waste falls into one of the following categories:

- **Characteristic Wastes:** includes wastes that are ignitable, corrosive, reactive, or toxic (D-listed).
- **Listed Wastes:** includes wastes from common manufacturing and industrial processes (F-listed), wastes from specific industries (K-listed), and wastes from commercial chemical products (U- and P-listed).
- **Universal Waste:** includes certain batteries (primarily rechargeable batteries such as lithium, nickel-cadmium, nickel metal hydride, and mercury oxide), mercury-containing equipment (e.g., thermometers, thermostats), and certain lamps (e.g., fluorescent bulbs). Note: alkaline batteries and incandescent bulbs are not considered Universal Wastes and can be legally disposed of as trash.
- **Mixed Waste:** hazardous waste mixed with radioactive waste.

EPA-regulated hazardous waste should not be mistaken for biological or radiological wastes. A more detailed definition of hazardous waste, including the D, F, P, and U lists, is provided in Appendices 1 and 2 of the Hazardous Waste Disposal Guidelines.

<http://www.purdue.edu/ehps/rem/home/booklets/hwdg.pdf>

## 7.2 Waste Identification and Labeling

All chemical constituents in a hazardous waste container must be identified by knowledgeable laboratory personnel. Not only is this required by the EPA, it also ensures that waste can be properly characterized and disposed of by REM. If there is uncertainty about the composition of a waste stream resulting from an experimental process, laboratory employees must consult the Laboratory Supervisor for assistance. In most cases, careful documentation and review of all chemical products used in the experimental protocol will result in accurate waste stream characterization. Additionally, review SDSs (specifically Section 2, "Hazard Identification" and Section 13, "Disposal Considerations") to obtain information about hazardous constituents and characteristics.

All waste should be properly labeled as soon the first drop of waste enters a waste container. Containers must be labeled and clearly marked with words that describe the contents of the waste and the words "Hazardous Waste". Hazardous waste should be listed completely on the label provided by REM in a percentage format as shown in Figure 7.1. Listing accurate percentages is not as important (+ 5% is acceptable and constituents less than 1% can be listed as "trace") as listing all of the chemicals that makeup the waste. If a chemical is found in the laboratory and the composition is unknown, it should be assumed to be hazardous and labeled as "Hazardous Waste – awaiting proper characterization".

| PURDUE UNIVERSITY HAZARDOUS WASTE DISPOSAL TAG |                      |                |
|--|----------------------|----------------|
| Chemical Ingredients                           |                      |                |
| Principle Investigator: <u>J. Smith</u>        |                      |                |
| Contents (Print)                               |                      |                |
| 1.   | <u>Acetone</u>       | % <u>50</u>    |
| 2.   | <u>Water</u>         | % <u>20</u>    |
| 3.   | <u>Hexane</u>        | % <u>10</u>    |
| 4.   | <u>Ethyl Acetate</u> | % <u>10</u>    |
| 5.   | <u>Chloroform</u>    | % <u>5</u>     |
| 6.   | <u>Methanol</u>      | % <u>5</u>     |
| 7.   | <u>Cadmium</u>       | % <u>Trace</u> |
| 8.   |                      | %              |
| 9.   |                      | %              |
| 10.  |                      | %              |
| Comments:                                      |                      |                |

Figure 7.1 – Purdue University Hazardous Waste Label

### 7.3 Waste Storage Requirements

Hazardous waste containers in Purdue laboratories are stored in satellite accumulation area (SAA). SAAs are used to manage hazardous waste in laboratories and shops because doing so provides safe and effective means to accumulate hazardous waste before removal by REM. Additionally, SAAs provide the least restrictive regulatory option for the accumulation and storage of hazardous waste containers. The following SAA rules must be followed at all times when managing hazardous waste in a laboratory:

- All waste must be stored in containers.
- Containers must be in good condition and compatible with the waste they contain (no corrosive waste in metal containers).
- Containers must be kept closed at all times except when adding or removing waste.
- Containers must be labeled or clearly marked with words that describe the contents of the waste (e.g., liquid chromatography waste) and the words "Hazardous Waste".
- Containers must be stored at or near the point of generation and under the control of the generator of the waste (wastes should remain in the same room they were generated in). A central waste collection room should not be established.
- The waste storage volume should never exceed 55 gallons per SAA.
- Containers should be segregated by chemical compatibility during storage (e.g., acids away from bases, secondary containment can be used as a means of segregation).
- Avoid halogenated and non-halogenated wastes in the same waste container.
- Avoid mixing incompatible waste streams in the same container (e.g., acids with bases, oxidizers with organic solvents) that will potentially create an exothermic reaction in the waste container. If mixing waste streams does create heat, allow the container to vent and cool in a chemical fume hood before sealing to avoid over pressurization of the container as illustrated in Figure 7.2.
- Collect all highly toxic, reactive, mercury and any exotic wastes (e.g., dioxin compounds, PCBs, controlled substances) separately even if they are chemically compatible with other waste streams. Failing to do so can result in costly disposal fees (e.g., mixing mercury with an organic solvent waste means that the entire waste stream must be treated as mercury waste).
- All spills and leaks should be cleaned up immediately.
- Identification of SAAs is not required by the EPA, but it is recommended as a good practice.



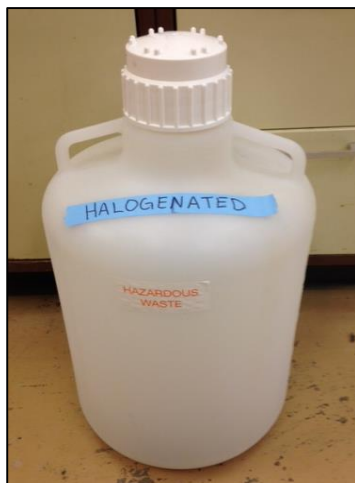


**Figure 7.2 – Container Failure Due to Mixing Incompatible Waste Streams**

## **7.4 Waste Containers**

REM does not provide containers to campus. It is the responsibility of the generator of the waste to provide containers. Usually the original container of the main component of the waste can be used (e.g., 4-liter glass jar, 5-gallon green metal solvent can). Purdue Stores also offers waste containers such as 20-liter carboys as shown in Figure 7.3 for sale.

If requested, reusable hazardous waste storage containers of 5 gallons or larger may be returned to the generator's area. Mark the container clearly with "Return to", the building, and room number as illustrated in Figure 7.4. Containers unsuitable for reuse will be properly disposed of and not returned.



**Figure 7.3 – 20 Liter Carboy**



**Figure 7.4 – Reusable Waste Container**

Purdue's policy for the disposal of empty containers is implemented to protect Purdue facilities and the Physical Facilities Buildings and Grounds staff when removing trash. Please remember that some chemical residues have the potential to mix with other incompatible residues in the dumpster or compactor causing a reaction or fire. In addition, sealed containers may become pressurized during compaction, which may result in residues spraying onto workers. Please keep the following procedures and information in mind when disposing of empty containers:

- Triple rinse empty containers with a solvent capable of removing the original material.
- Collect the rinsate for disposal through REM.
- Identify triple-rinsed, dry, odorless, and empty containers by placing a "Safe for Disposal" label on the container (Figure 7.5). Contact REM at (765) 494-0121 to request a supply of these labels.
- Remove any cap that may cause the container to become pressurized when compacting.
- Arrange removal of these containers with the Building Services staff in your area or take these containers to the designated area beside the dumpster outside your building.
- If unable to remove residual hazardous materials from containers, submit these to REM for pickup using the Hazardous Materials Pickup Request Form.



**Figure 7.5 – Safe for Disposal Label**



## 7.5 Waste Disposal Procedures

REM provides pickup services for all chemical waste generated on the West Lafayette campus. A Hazardous Materials Pickup Request form must be completed and submitted by the generator of the waste to initiate pickup services. Once the pickup request has been processed, REM staff will come to your lab to pick up the waste. Average turnaround time is 3-5 days.

The following procedures must be followed in order to have hazardous waste removed from campus locations:

1. Prior to pick up, all waste must be placed in a designated area within the room where the waste was generated.
2. All waste must be placed in an appropriate container(s).
3. All containers must be capped and labeled.
4. Complete and submit a Hazardous Materials Pickup Request form (Figure 7.6). Visit the REM's Forms webpage (<http://www.purdue.edu/ehps/rem/home/form.htm#hmm>) to find the online Hazardous Material Pickup Request submission form.

For further information regarding hazardous waste disposal, call REM at (765) 494--0121 or visit the REM website. (<http://www.purdue.edu/ehps/rem/hmm/hmm.htm>)

HMM-001

### Hazardous Material Pickup Request

Send to **REM, LMSB** via campus mail or **Fax 49-61106**

PI: \_\_\_\_\_ PI Telephone #: \_\_\_\_\_

Requested By: \_\_\_\_\_ Date: \_\_\_\_\_

Telephone #: \_\_\_\_\_ E-Mail: \_\_\_\_\_

Building: \_\_\_\_\_ Room/Shop: \_\_\_\_\_ Waste Location

Department: \_\_\_\_\_ Dept. Code: \_\_\_\_\_

**When filling out this form remember the following:**

1. All mixture materials must be submitted in a percentage format. Each Container's percentage must add up to 100% (See Example Below).
2. Chemical descriptions on this form must match the container label.
  - Always include as much information as possible.
  - Only submit known mixtures or chemicals.
  - Absolutely no chemical formulae, abbreviations, acronyms or structures.
3. When submitting trade products:
  - It is your responsibility to provide the product information.
  - An accurate chemical description of the product must accompany the form (i.e. an MSDS).
4. Make sure all writing is legible.
5. Forms completed improperly can cause severe delays in pickup times.

**Example Pickup Line:**

|   |   |   |        |        |   |   |
|---|---|---|--------|--------|---|---|
| 1 | Acetone 50%, Benzene 10%, Dichloromethane 20%, Acetic Acid 10%, Water 10%, Trace Silver | 5 | 5 gal. | 5 gal. | S | L |
|---|---|---|--------|--------|---|---|

I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

| Item # | Chemical Description (List Each Container) | Number of Containers | Container Size | Amount of Waste In Container | Spent/ Usable | Solid/ Liquid/ Gas/ Aerosol |
|--------|--|----------------------|----------------|------------------------------|---------------|-----------------------------|
|        |  |                      |                |                              |               |                             |
|        |  |                      |                |                              |               |                             |

↕

**Special Comments or Instructions:**

1

Figure 7.6 – Hazardous Materials Pickup Request

## 7.6 Unknown Chemical Waste

Unknown chemicals are a serious problem in laboratories. Mysterious chemicals are often stored in labs for years before lab personnel notice the unidentified items. However, steps can be taken to assist with proper management of unknowns. Unknown chemicals must be properly identified according to hazard class before proper disposal. The hazards that should be noted include: corrosive, flammable, oxidizer, reactive, toxic, and radioactive. The following subsections describe in detail how to properly manage unknown chemicals.

### 7.6.1 Labeling Unknown Chemicals

Until the unknown chemical can be properly identified by either lab staff or REM, the container should be labeled with a Hazardous Waste Disposal Tag. The following information should be written on the label: “Unknown hazardous chemical, awaiting proper characterization by REM” as illustrated in Figure 7.7.



Figure 7.7 – Properly Labeled Unknown Waste

### 7.6.2 Identifying Unknown Chemicals

Every effort should be made by laboratory personnel to identify unknown chemicals. Here are a few steps that can be taken to help this effort:

1. Ask other laboratory personnel if they are responsible for, or can help identify the unknown chemical.
2. The type of research conducted in the laboratory can be useful information for making this determination. Eliminating certain chemicals as a possibility helps narrow the problem as well. This is especially important for mercury, PCB, or dioxin compounds because they must be managed separately from other hazardous waste.
3. For trade products, contact the manufacturer or search online to obtain an SDS. REM staff can assist you in finding an SDS.

### 7.6.3 Removing Unknown Chemicals from the Work Area

If it is not possible to identify the material, a "Hazardous Waste" label should be placed on the container as described above in Section 7.6.1 and a Hazardous Materials Pickup Request form should be submitted which describes all of the available information (e.g., 4-liter container of clear liquid). Call REM at (765) 494-0121 if you have a question about an unknown.

### 7.6.4 Preventing Unknown Chemicals

Here are a few tips that will help prevent the generation of unknown chemicals:

- Label all chemical containers, including beakers, flasks, vials, and test tubes. The label should be placed on the container, not the cap to avoid accidental mislabeling.
- Immediately replace labels that have fallen off or that are deteriorated.
- Label containers using chemical names. Do not use abbreviations, structure, or formulae.
- Archived research samples are often stored in boxes containing hundreds of small vials. Label the outside of the box with the chemical constituents paying special attention to regulated materials such as radioactive material, organic solvents, heavy metals and other toxics. If the samples are nonhazardous, label them as such.
- Submit frequent Hazardous Materials Pickup Request Forms to reduce the amount of chemicals in your laboratory.
- Employees should dispose of all of their waste before leaving/graduating from Purdue. The lab and/or department should come up with a system to ensure that all faculty, staff, and students properly dispose of hazardous waste, including unwanted research samples, before employees leave.

## 7.7 Sink and Trash Disposal

No chemical waste should be poured down the drain or discarded in the trash unless it is certain that doing so does not violate hazardous waste regulations or the West Lafayette wastewater treatment plant's discharge requirements. In order to ensure improper disposal does not occur, the detailed instruction and guidelines for acceptable sink disposal is provided in the Purdue University Hazardous Waste Disposal Guidelines (Chapter 5.6, Appendix E, and Appendix F: <http://www.purdue.edu/ehps/rem/home/booklets/hwdg.pdf>). Please contact REM at (765) 494-0121 for further information regarding non-hazardous chemical waste disposal.

## 7.8 Sharps Waste

Sharps are items capable of puncturing, cutting, or abrading the skin such as glass or plastic pipettes, broken glass, test tubes, petri dishes, razor blades, needles, and syringes with needles. Sharps waste contaminated with hazardous chemicals must be placed into puncture resistant containers (e.g., sharps container, plastic or metal container with lid) and properly labeled as detailed in Chapter 4 of the Purdue University Hazardous Waste Guidelines. All chemically contaminated waste should be inventoried on a Hazardous Materials Pickup Request form and sent to REM for proper disposal.

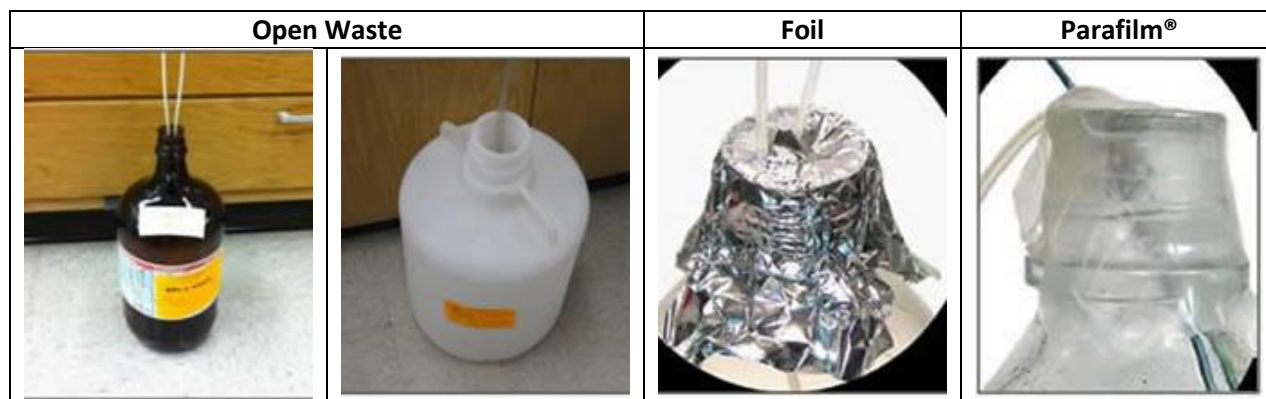
Clean uncontaminated broken glassware and plastic sharps should be placed in a corrugated cardboard box or other strong disposable container. Do not exceed 20 pounds. When ready for disposal, the box should be taped shut and prominently labeled as "Sharp Objects/Glass – Discard" or similar wording. The "Safe for Disposal" label (Figure 7.5) should also be affixed to the outside of the container. Contact your Physical Facilities Building Services department for specific non-hazardous waste disposal instructions. More detail regarding sharps, including biologically contaminated sharps, can be found in the REM Sharps and Infectious Waste Handling and Disposal Guidelines.

<http://www.purdue.edu/ehps/rem/home/booklets/sharps.pdf>

## 7.9 Liquid Chromatography Waste

Liquid chromatography (LC) is an analytical technique used to separate, identify, quantify, and purify individual components of a mixture. This technique is very common in biological and chemical research. The most common type of LC at Purdue is High Performance Liquid Chromatography (HPLC). Purdue has numerous LC instruments located in laboratories all over campus. Because organic solvents (e.g., methanol, acetonitrile) are commonly used in the process, most LC waste is regulated by the EPA as hazardous waste. Consequently, all containers collecting LC waste must remain closed while the LC unit is in operation. It is neither

acceptable to place a waste line running from the LC unit into an open waste container nor is it acceptable to use foil or Parafilm® as a means of closure as shown in Figure 7.8.



**Figure 7.8 – Improper LC Waste Collection Practices**

One of the following practices must be employed in order to comply with hazardous waste regulations for LC waste collection systems:

1. Purchase an engineered container and/or cap designed for LC waste collection. Figure 7.9 shows several examples of acceptable solutions for proper LC waste collection that can be purchased.



**Figure 7.9 – Proper LC Waste Collection Options for Purchase**

2. An existing cap can be modified by the research lab for LC waste collection. To modify an existing cap, a hole can be drilled into a cap. The diameter of the hole should be similar to the diameter of the waste line; there should be a tight fit between the container opening and waste line. In addition, a hole should be drilled to accommodate any exhaust filter or air valve tube that may be required. It is recommended that either a 4-liter container or 5-gallon carboy be used for waste collection. The modified cap should be replaced with a regular, unmodified cap once the container is full and ready for REM pickup. See Figure 7.10 for examples of acceptable modified caps.

## Chapter 8: Chemical Spills

Chemical spills in the laboratory can pose a significant risk to human health and the environment. All lab personnel must be trained on how to properly respond to chemical spills in order to minimize risk. In general, chemical spills can be placed into one of two categories: non-emergency chemical spills, or emergency chemical spills.

### 8.1 Non-Emergency Chemical Spill Procedures

Non-emergency chemical spills are generally defined as less than 1 liter, do not involve a highly toxic or reactive material, do not present a significant fire or environmental hazard, and are not in a public area such as a hallway. These spills can be cleaned up by properly trained lab personnel using conventional lab PPE (e.g., safety glasses/goggles, lab coat, gloves) and the lab spill kit. In general, when a non-emergency spill occurs in the lab the area around the spill should be isolated, everyone in the lab should be made aware of the spill, and the spilled material should be absorbed and collected using either pads or some other absorbent material such as oil dry or kitty litter. Decontamination of the spill area should be conducted using an appropriate solvent (soap and water is often the most effective). Proper PPE should be worn at all times and only trained personnel should conduct the cleanup. Additionally, review the SDS(s) (specifically Section 6, "Accidental Release Measures") to obtain chemical-specific cleanup information.

### 8.2 Emergency Chemical Spill Procedures

Emergency chemical spills are generally defined as greater than 1 liter, involve a highly toxic or reactive compound, present an immediate fire or environmental hazard, or require additional PPE (e.g., respirator) and specialized training to properly cleanup. The following procedures should be followed in the event of an emergency chemical spill:



- Cease all activities and immediately evacuate the affected area (make sure that all personnel in the area are aware of the spill and also evacuate).
- If chemical exposure has occurred to the skin or eyes, the affected personnel should be taken to the nearest safety shower and eyewash station.

- Dial 911, which will initiate both the Purdue Police and Purdue Fire Department response, if the situation is, or could become an emergency (e.g., chemical exposure has occurred, a fire or explosion has occurred).
- The fire alarm should be pulled, which will initiate building evacuation, if any of the following occurs:
  - A fire and/or explosion has occurred (or there is a threat of fire and/or explosion);
  - The large spill (which is either highly toxic or presents an immediate fire or environmental hazard) is in a public area such as a hallway;
  - Toxic vapors are leaving the area where the spill has occurred, such as seeping from the laboratory into the hallway or neighboring rooms;
  - You are unsure of the hazards and feel that the spill could be harmful to building occupants.
  - Ensure that no one else is allowed to enter the area until the spill has been properly cleaned up by the Purdue Fire Department.

### 8.3 Chemical Spill Kits

Each laboratory should have a spill response kit available for use. Lab spill kits can either be purchased from a vendor or created by lab personnel, but each spill kit should be equipped to handle small spills of the most common hazards in the laboratory. The kit should be equipped with response and cleanup materials such as:

- Absorbent materials such as pads, booms, oil dry or kitty litter, booms, or pillows
- Neutralizing agents (e.g., Neutrasorb®) for acids and/or bases if high volume of acids and/or bases are stored in the laboratory
- Containers such as drums, buckets, and/or bags to containerize spilled material and contaminate debris generated during the cleanup process
- PPE such as gloves, safety glasses and/or goggles, lab coat or apron, chemical-resistant booties
- Caution tape or some other means to warn people of the spill



## Chapter 9: Training

Effective training is crucial to a successful laboratory safety program. Laboratory Supervisors must actively participate in the training process to ensure that all lab employees are effectively trained before any work with hazardous materials occurs. This chapter details the minimum training requirements for all Purdue laboratories. It should be noted that depending on the type of research being conducted and associated hazards, there may be additional training requirements that are not detailed in this chapter. For more information, contact REM at (765) 494-6371 or visit the REM Training webpage.

(<http://www.purdue.edu/ehps/rem/home/training.htm>)

### 9.1 CHP Training

As discussed in Chapter 1 of the CHP, all laboratory employees (graduate students, lab technicians/managers, post-docs, visiting scientists, etc.) must receive documented CHP training before any work with hazardous materials occurs. The Laboratory Supervisor is responsible for providing CHP training. Initial CHP training should include the following:

- Review the lab-specific CHP in its entirety
- Review lab-specific hazard assessments
- Review lab-specific SOPs
- Review any other lab-specific protocol or requirements

Refer to Appendix A for the CHP Lab-Specific Training Certification form, which can be used to document having read the CHP.

#### 9.1.1 Lab Safety Fundamentals Online Training

The Lab Safety Fundamentals (LSF) online training was developed to provide basic laboratory safety training for individuals working with recognized hazards in the laboratory. This training is ideal for first year graduate students. LSF online training is a course offered through Purdue University's Learning Management System created by Vivid Learning Systems. The training covers mainly chemical hazards but is appropriate for all individuals that work in research laboratories. It should be completed prior to starting work in the laboratory. Each trainee must complete the 3 modules and take the exam to receive training credit. For access to the LSF online training, visit the REM webpage.

(<https://www.purdue.edu/ehps/rem/ih/chptraining.htm>)



### 9.1.2 Annual CHP Refresher Requirements

After receiving the initial documented CHP training, all lab employees must receive annual CHP refresher training as well. This annual refresher training can be a condensed version of the initial CHP training, but should include at least the following elements:

- Review of the lab-specific hazard assessments (review of PPE requirements)
- Review of the lab-specific SOPs
- Review of any additional lab-specific rules and requirements
- Review of chemical spill and lab emergency procedures

## 9.2 PPE Training

As discussed in Chapter 6 of the CHP, Laboratory Supervisors must ensure that all lab employees receive documented PPE training before any work with hazardous materials occurs. Document PPE training using the Certification of Training form (Appendix B of the Purdue University Personal Protective Equipment (PPE) Policy:

<http://www.purdue.edu/ehps/rem/home/booklets/PPEPolicy.pdf> or get it directly from <http://www.purdue.edu/ehps/rem/home/forms/CertT.pdf>. Each lab employee must be trained to know at least the following:

- When PPE is necessary
- What PPE is necessary
- How to properly don, doff, adjust, and wear PPE
- The limitations of the PPE
- The proper care, maintenance, and useful life of PPE

Each affected employee must demonstrate an understanding of the training provided, and the ability to use the PPE properly, before performing any work requiring the use of PPE.

## 9.3 SOP Training

As discussed in Chapter 4 of the CHP, SOPs are written instructions that detail the steps that will be performed during a given procedure and include information about potential hazards and how these hazards will be mitigated. SOPs must be developed for all hazardous tasks that are performed in the lab. Laboratory Supervisors must ensure that all applicable personnel receive documented training on lab-specific SOPs. More information regarding SOPs can be found on the REM website. (<http://www.purdue.edu/ehps/rem/home/sop.htm>)

## 9.4 Laboratory Chemical Safety Course (CHM 605)

The Purdue Department of Chemistry offers a graduate level, zero credit fall-semester course (CHM 605) that covers the fundamentals of laboratory chemical safety practices. CHM 605 includes a strong focus on learning how to find, read, interpret and use the information in safety data sheets, chemical labels, and other printed chemical safety information. Other topics covered include fire protection/prevention, electrical safety, laser and ionizing radiation safety, machine safety (pumps, autoclaves, centrifuges), and non-PPE safety equipment (hoods, extinguishers, fire protection systems and building elements, general ventilation, showers, eyewashes), and an understanding of administrative controls, engineering controls, and how to select, use, maintain and decide to retire/replace PPE necessary for laboratory work with chemicals. Regulatory agency familiarity and compliance topics including OSHA, EPA, DOT, and NRC are also included. CHM 605 is open to all departments and is a required course for some departments. All graduate students working in a laboratory environment are strongly encouraged to take CHM 605.

## 9.5 REM Researcher's Guide

The CHP focuses on work with hazardous chemicals in the laboratory. However, other common types of hazards are present in many research labs as well (e.g., biological hazards, lasers, etc.). REM has developed the Researcher's Guide as a tool to assist researchers with compliance and training requirements for a broad range of common hazards and regulatory programs found in the laboratory. Visit the REM Researcher's Guide for more detailed information.

<http://www.purdue.edu/ehps/rem/home/researchers.htm>

# **Appendix A:**

# **Lab-Specific**

# **Training Certification Form**

**PURDUE UNIVERSITY**  
**Chemical Hygiene Plan**

**Lab-Specific Training Certification**

*(Please Type or Print Legibly)*

**For:** Gaurav Chopra Lab, Drug Discovery Research Facility, 210A, 210B, 274A, 274B, 261, 263

*Laboratory Supervisor, Building, and Room(s)*

After reading your lab-specific Purdue Chemical Hygiene Plan, complete and return a copy of this form to your Laboratory Supervisor. By signing below you acknowledge that you understand your lab-specific Chemical Hygiene Plan and the policies and procedures applicable to the OSHA Occupational Exposure to Hazardous Chemicals in Laboratories Standard (29 CFR 1910.1450). Your Laboratory Supervisor will provide additional information and training as appropriate.

Name: \_\_\_\_\_ Work Telephone: \_\_\_\_\_

Email Address: \_\_\_\_\_

Department: \_\_\_\_\_

Job Title: \_\_\_\_\_

Employee Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Filing:**

File each employee's completed Chemical Hygiene Plan Lab-Specific Training Certification form in a central administrative location. These and all other safety training records should be organized in a way that allows original records for a single staff member or for an entire work group (as identified by the Laboratory Supervisor) to be retrieved quickly and efficiently on request by an OSHA inspector or a REM staff member.

# **Appendix B:**

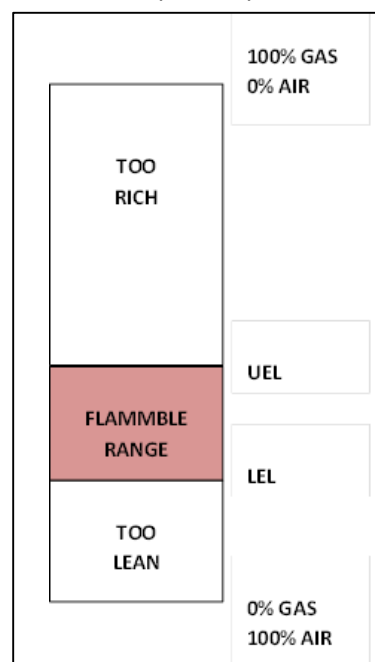
## **OSHA Hazard Class Definitions**

## B.1 Physical Hazards

### B.1.1 Flammable Liquids

Flammable hazards are materials which under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source. Flammable liquids (e.g., hexane, ethyl acetate, xylene) are more hazardous at elevated temperatures due to more rapid vaporization. The following definitions are important to understand when evaluating the hazards of flammable liquids:

- **Flammable liquid** is a liquid having a flash point no greater than 93 °C (200 °F).
- **Flash point** is the minimum temperature at which the application of an ignition source causes the vapors of a liquid to ignite under specified test conditions.
- **Boiling point** is the temperature at which the vapor pressure of a liquid equals the atmospheric pressure and the liquid changes into a vapor.
- **Auto ignition temperature** is the minimum temperature at which self-sustained combustion will occur in the absence of an ignition source.
- **Lower explosive limit (LEL)** is the lowest concentration (percentage) of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat).
- **Upper explosive limit (UEL)** is the highest concentration (percentage) of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat).



Some organic solvents (e.g., diethyl ether) have the potential to form potentially shock-sensitive organic peroxides. See Appendix 3 for additional information regarding peroxide forming chemicals.

Chapter 5.7.2 of the CHP details flammable liquids storage requirements.

### B.1.2 Flammable Solids

A flammable solid is a solid which is readily combustible, or may cause or contribute to a fire through friction. Readily combustible solids are powdered, granular, or pasty substances which

are dangerous if they can be easily ignited by brief contact with an ignition source. Flammable solids are more hazardous when widely dispersed in a confined space (e.g., finely divided metal powders).

### B.1.3 Gases under Pressure

Gases under pressure are gases which are contained in a receptacle at a pressure not less than 280 kPa at 20 °C or as a refrigerated liquid. Gases under pressure include the following:



- **Compressed gas** is a gas which when packaged under pressure is entirely gaseous at -50 °C; including all gases with a critical temperature  $\leq$  -50 °C.
- **Liquefied gas** is a gas which when packaged under pressure is partially liquid at temperatures above -50 °C.
- **Refrigerated liquefied gas** is a gas which when packaged is made partially liquid because of its low temperature.
- **Dissolved gas** is a gas which when packaged under pressure is dissolved in a liquid phase solvent.

All compressed gases are hazardous due to the fact they are stored in compressed cylinders, which can explode and act as a projectile if ruptured. Compressed gases also carry the hazards of the chemicals they contain such as asphyxiation (carbon dioxide), toxicity (nitric oxide), flammable (propane), and corrosive (hydrogen chloride).

Chapter 5.7.3 of the CHP details compressed gases storage requirements.

### B.1.4 Pyrophoric, Self-Heating, and Self-Reactive Materials

**Pyrophoric material** (also called “spontaneously combustible”) is a liquid or solid that even in small quantities and without an external ignition source can ignite after coming in contact with the air.

**Self-heating material** is a solid or liquid, other than a pyrophoric substance, which, by reaction with air and without energy supply, is liable to self-heat. This endpoint differs from a pyrophoric substance in that it will ignite only when in large amounts (kilograms) and after long periods of time (hours or days).



**Self-reactive material** is a thermally unstable liquid or solid liable to undergo a strongly exothermic thermal decomposition even without participation of oxygen (air).

Chapter 5.7.4 of the CHP details the storage requirements for reactive chemicals.

### B.1.5 Water-Reactive Materials

A water-reactive material is a liquid or solid that reacts violently with water to produce a flammable or toxic gas, or other hazardous conditions. Alkali metals (e.g., sodium, potassium) and metal hydrides (e.g., calcium hydride) are common water-reactive materials found in laboratories.



Chapter 5.7.4 of the CHP details the storage requirements for reactive chemicals.

### B.1.6 Oxidizers

An oxidizing solid/liquid is a solid/liquid which, while in itself is not necessarily combustible, may generally by yielding oxygen, cause or contribute to the combustion of other material. Hydrogen peroxide, nitric acid, and nitrate solutions are examples of oxidizing liquids commonly found in a laboratory. Sodium nitrate, Sodium perchlorate, and Potassium permanganate are examples of oxidizing solids commonly found in a laboratory.

Chapter 5.7.7 of the CHP details oxidizer storage requirements.

### B.1.7 Organic Peroxides

An organic peroxide is an organic liquid or solid which contains the bivalent -O-O- structure and may be considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. The term also includes organic peroxide formulations (mixtures). Such substances and mixtures may:

- Be liable to explosive decomposition;
- Burn rapidly;
- Be sensitive to impact or friction; or
- React dangerously with other substances



Chapter 5.7.7 of the CHP details organic peroxide storage requirements.



### B.1.8 Explosives

An explosive substance (or mixture) is a solid or liquid substance (or mixture of substances) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed that can cause damage to the surroundings. Pyrotechnic substances are included even when they do not evolve gases. A pyrotechnic substance (or mixture) is designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as the result of non-detonative, self-sustaining, exothermic chemical reactions. An explosive compound that is sometimes found in a laboratory setting is picric acid (2,4,6-trinitrophenol).



If a laboratory plans to work with explosive compounds, contact REM for further instructions before any work occurs.

## B.2 Health Hazards

A chemical is a health hazard if there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Each health hazard is defined and briefly discussed below.

### B.2.1 Irritants

Irritants are defined as chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds, including many chemicals that are in a powder or crystalline form, are irritants. Symptoms of exposure can include reddening or discomfort of the skin and irritation to respiratory systems.



### B.2.2 Sensitizers

A sensitizer (allergen) is a substance that causes exposed individuals to develop an allergic reaction in normal tissue after repeated exposure to the substance. Examples of sensitizers include diazomethane, chromium, nickel, formaldehyde, isocyanates, arylhydrazines, benzylic and allylic halides, and many phenol derivatives. Sensitizer exposure can lead to all of the symptoms associated with allergic reactions, or can increase an individual's existing allergies.

### B.2.3 Corrosives

Corrosive substances cause destruction of living tissue by chemical corrosion at the site of contact and can be either acidic or caustic (basic). Major classes of corrosive substances include:

- Strong acids such as sulfuric, nitric, hydrochloric and hydrofluoric acids
- Strong bases such as sodium hydroxide, potassium hydroxide, and ammonium hydroxide
- Dehydrating agents such sulfuric acid, sodium hydroxide, phosphorus pentoxide and calcium oxide
- Oxidizing agents such as hydrogen peroxide, chlorine, and bromine



Chapter 5.7.6 of the CHP details corrosives storage requirements.

### B.2.4 Hazardous Substances with Toxic Effects on Specific Organs

Substances with toxic effects on specific organs include:

- Hepatotoxins, which are substances that produce liver damage, such as nitrosamines and carbon tetrachloride.
- Nephrotoxins, which are substances that cause damage to the kidneys, such as certain halogenated hydrocarbons.
- Neurotoxins, which are substances that produce toxic effects on the nervous system, such as mercury, acrylamide, and carbon disulfide.
- Substances that act on the hematopoietic system (e.g., carbon monoxide and cyanides), which decrease hemoglobin function and deprive the body tissues of oxygen.
- Substances that damage lung tissue such as asbestos and silica.



### B.2.5 Particularly Hazardous Substances

Substances that pose such significant threats to human health are classified as "particularly hazardous substances" (PHSs). The OSHA Laboratory Standard requires that special provisions be established to prevent the harmful exposure of researchers to PHSs, including the establishment of designated areas for their use. Particularly hazardous substances are divided into three primary types:

1. Carcinogens

2. Reproductive Toxins
3. Substances with a High Acute Toxicity

#### **B.2.5.1 Carcinogens**

Carcinogens are chemical or physical agents that cause cancer. Generally they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period. Chronic toxins are particularly insidious because they may have no immediately apparent harmful effects. These materials are separated into two classes:

1. **Select Carcinogens:** Select carcinogens are materials which have met certain criteria established by the National Toxicology Program or the International Agency for Research on Cancer regarding the risk of cancer via certain exposure routes. It is important to recognize that some substances involved in research laboratories are new compounds and have not been subjected to testing for carcinogenicity.
2. **Regulated Carcinogens:** Regulated carcinogens are more hazardous and have extensive additional requirements associated with them. The use of these agents may require personal exposure sampling based on usage. When working with Regulated Carcinogens, it is particularly important to review and effectively apply engineering and administrative safety controls as the regulatory requirements for laboratories that may exceed long term (8 hour) or short term (15 minutes) threshold values for these chemicals are very extensive.

#### **B.2.5.2 Reproductive Toxins**

Reproductive toxins include any chemical that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogens). Reproductive toxins can affect the reproductive health of both men and women if proper procedures and controls are not used. For women, exposure to reproductive toxins during pregnancy can cause adverse effects on the fetus; these effects include embryoletality (death of the fertilized egg, embryo or fetus), malformations (teratogenic effects), and postnatal functional defects. For men, exposure can lead to sterility. Examples of embryotoxins include thalidomide and certain antibiotics such as tetracycline. Women of childbearing potential should note that embryotoxins have the greatest impact during the first trimester of pregnancy. Because a woman often does not know that she is pregnant during this period of high susceptibility, special caution is advised when working with all chemicals, especially those rapidly absorbed through the skin (e.g., formamide).

### B.2.5.3 Substances with a High Acute Toxicity

Substances that have a high degree of acute toxicity are materials that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. Acute toxins are quantified by a substance's lethal dose-50 (LD<sub>50</sub>) or lethal concentration-50 (LC<sub>50</sub>), which is the lethal dose of a compound to 50% of a laboratory tested animal population (e.g., rats, rabbits) over a specified time period. High acute toxicity includes any chemical that falls within any of the following OSHA-defined categories:

- A chemical with a median lethal dose (LD<sub>50</sub>) of 50 mg or less per kg of body weight when administered orally to certain test populations.
- A chemical with an LD<sub>50</sub> of 200 mg less per kg of body weight when administered by continuous contact for 24 hours to certain test populations.
- A chemical with a median lethal concentration (LC<sub>50</sub>) in air of 200 parts per million (ppm) by volume or less of gas or vapor, or 2 mg per liter or less of mist, fume, or dust, when administered to certain test populations by continuous inhalation for one hour, provided such concentration and/or condition are likely to be encountered by humans when the chemical is used in any reasonably foreseeable manner.



Chapter 5.7.5 of the CHP details acutely toxic compounds storage requirements.

# **Appendix C:**

# **Peroxide Forming Chemicals**

## Peroxide Forming Chemicals

Autoxidation in common laboratory solvents can lead to unstable and potentially explosive peroxide formation. The reaction can be initiated by exposure to air, heat, light, or contaminants. Most of these solvents are available with inhibitors to slow the peroxide formation. Examples of inhibitors include BHT (2,6-di-tert-butyl-4-methyl phenol) and Hydroquinone. There are three categories of peroxide formers:

**Group A** chemicals are those which form explosive levels of peroxides after prolonged storage, especially after exposure to air without concentration. Test these for peroxide formation before using and discard 3 months after opening.

| Table C.1 – Group A Chemicals |                     |
|-------------------------------|---------------------|
| Butadiene                     | Isopropyl ether     |
| Chloroprene                   | Tetrafluoroethylene |
| Divinylacetylene              | Vinylidene chloride |

**Group B** chemicals form peroxides that are hazardous only on concentration by distillation or evaporation. Test these before distillation and discard after 12 months.

| Table C.2 – Group B Chemicals |                                  |                        |
|-------------------------------|----------------------------------|------------------------|
| Acetal                        | Dicyclopentadiene                | Methyl isobutyl ketone |
| Acetaldehyde                  | Diethyl ether                    | 4-Methyl-2-pentanol    |
| Benzyl alcohol                | Diethylene glycol dimethyl ether | 2-Pentanol             |
| 2-Butanol                     | Dioxane                          | 4-Penten-1-ol          |
| Cumene                        | Ethylene glycol dimethyl ether   | 1-Phenylethanol        |
| Cyclohexanol                  | 4-Heptanol                       | 2-Phenylethanol        |
| 2-cyclohexen-1-ol             | 2-Hexanol                        | 2-Propanol             |
| Cyclohexene                   | Methylacetylene                  | Tetrahydrofuran        |
| Decahydronaphthalene          | 3-Methyl-1-butanol               | Tetrahydronaphthalene  |
| Diacetylene                   | Methylcyclopentane               | Vinyl ether            |

**Group C** chemicals consist of monomers which form peroxides that can initiate explosive polymerization. Inhibited monomers should be tested before use and discarded after 12 months. Uninhibited monomers should be discarded 24 hours after opening.

| <b>Table C.3 – Group C Chemicals</b> |                     |
|--------------------------------------|---------------------|
| Acrylic acid                         | Styrene             |
| Acrylonitrile                        | Tetrafluoroethylene |
| Butadiene                            | Vinyl acetate       |
| Chloroprene                          | Vinyl acetylene     |
| Chlorotrifluoroethylene              | Vinyl chloride      |
| Methyl methacrylate                  | Vinyl pyridine      |

### General Guidelines

- Solvents containing inhibitors should be used whenever possible.
- All peroxide forming solvents should be tested prior to distillation.
- Peroxide forming solvents should be purchased in limited quantities.
- Peroxide forming solvents should be marked with the purchase date and the date opened.
- Peroxide forming solvents should be sealed tightly and stored away from light and heat.
- Periodic testing should be done on opened containers and the results marked on the containers.

### Testing

- Obtain test strips for the range of 0-100 ppm peroxide.
- Record the test results on the bottle.
- If the test results are 100 ppm or greater, contact REM at (765) 494-0121 for proper disposal.

## **Tab 1:**

# **Lab-Specific Standard Operating Procedures**

[Click here to enter text.](#)



## Chopra Lab Standard Operating Procedures

### Title: Disposal of Sharps

Updated: February 1<sup>st</sup>, 2016

This SOP is to serve as a guide for the proper disposal of various tips and sharps. In this protocol, a 'sharp' refers to any object which is rigid and even remotely pointy such that it could pierce through a common garbage bag. This includes but is not limited to pipette tips, serological pipettes (the long, graduated ones), razor blades, glass tubes or bottles (broken or intact), and needles (even with the plastic guard).

**Under no circumstance should a sharp of any kind be placed in a regular trash can.**

**Glass-** Glass may be disposed of in the cardboard broken glass boxes located throughout the labs. No liquids or other solids of any kind should ever be disposed of in these boxes- **ONLY GLASS!** Under no circumstance should needles or razor blades be placed in here and never discard Pasteur pipettes or other sharps contaminated with organic chemicals (even traces) in these boxes as they leave unpleasant odors and may leak and react with other chemicals from improperly disposed of sharps (see sharps contaminated with hazardous chemicals below). Glass boxes should be filled no more than 2/3 full, after which the lid should be duct taped securely closed and the box should be set aside for removal by custodial staff.

**Non-hazardous sharps-** Sharps which present no real hazard other than being rigid and pointy (e.g. pipette tips used for water or buffer) can be collected in any rigid plastic or cardboard container with an appropriate label such as "Tips" or "Non-Hazardous Sharps". When full, this container should be closed securely (with tape if necessary) and may be placed in the regular trash. Tips or sharps contaminated with any hazardous chemicals must be disposed of through REM as described below (see sharps contaminated with hazardous chemicals below). For serological (graduated) pipettes, if a large enough box or plastic container is not available, pipettes (even those just used for water or medium) can be disposed of in the biohazard bag next to the biosafety cabinet.

**Biohazardous Sharps-** This could include needles, serological pipettes, pipette tips, and glass (coverslips, tubes, etc) and anything else rigid, pointy, and contaminated with a biohazardous agent.

**Needles-** Needles and other sharps contaminated with human blood or other biohazardous agents can be disposed of in a red plastic sharps box. These boxes are not free so care should be taken to not fill them unnecessarily- trash items like gloves and paper towels should go in the biohazard bags instead. If possible, syringes and needles should be separated as the syringe can be placed in a biohazard bag while the needle must go in the red box or other rigid container. Once a red biohazardous sharps box reaches  $\frac{3}{4}$  full, it should be autoclaved and disposed of as biological waste.

**Tips-** Pipette tips contaminated by human blood or other biohazardous agent can fill a red biohazardous sharps box very quickly. An alternative method is to use any rigid container with a tightly closing lid (empty reagent or medium bottles work well, as do used 50mL centrifuge tubes). The container should be labeled as biohazardous tips and the lid should be kept on when not in use. When the container is full, it should be capped and placed in a biohazardous waste bag for autoclave sterilization (no excess liquid should be added to these containers since they WILL EXPLODE in the autoclave!)

**Sharps contaminated with hazardous chemicals-** Sharps such as needles used with organic reagents which have trace amounts of hazardous chemicals should be collected separately and disposed of as hazardous waste through REM. These can be collected along with solid waste (or separate if appropriate) in a rigid, leak-proof plastic container- if a red biohazardous sharps box is used, the biohazard symbol must be covered, defaced, or otherwise removed. Care should be taken to track what has been added to this waste box so that an accurate description can be given at the time of removal. Disposal of any hazardous materials should be in accordance with REM's **CHEMICAL HANDLING AND DISPOSAL GUIDELINES** and any EPA regulated waste must be noted, even in trace amounts (see Tables below V and VI in the **CHEMICAL**

**HANDLING AND DISPOSAL GUIDELINES** shown below or the REM website: <http://www.purdue.edu/rem/hmm/chemwast.htm>).

**TABLE V: TOXICITY CHARACTERISTIC WASTE CODES (D004 - D043)**

| EPA Waste Code | Chemical Name        | EPA Waste Code | Chemical Name                |
|----------------|----------------------|----------------|------------------------------|
| D004           | Arsenic              | D024           | m-Cresol                     |
| D005           | Barium               | D025           | p-Cresol                     |
| D006           | Cadmium              | D026           | Cresol                       |
| D007           | Chromium             | D027           | 1,4-Dichlorobenzene          |
| D008           | Lead                 | D028           | 1,2-Dichloroethane           |
| D009           | Mercury              | D029           | 1,1-Dichloroethylene         |
| D010           | Selenium             | D030           | 2,4-Dinitrotoluene           |
| D011           | Silver               | D031           | Heptachlor (and its epoxide) |
| D012           | Endrin               | D032           | Hexachlorobenzene            |
| D013           | Lindane              | D033           | Hexachlorobutadiene          |
| D014           | Methoxychlor         | D034           | Hexachloroethane             |
| D015           | Toxaphene            | D035           | Methyl ethyl ketone          |
| D016           | 2,4-D                | D036           | Nitrobenzene                 |
| D017           | 2,4,5-TP (Silvex)    | D037           | Pentachlorophenol            |
| D018           | Benzene              | D038           | Pyridine                     |
| D019           | Carbon tetrachloride | D039           | Tetrachloroethylene          |
| D020           | Chlordane            | D040           | Trichloroethylene            |
| D021           | Chlorobenzene        | D041           | 2,4,5-Trichlorophenol        |
| D022           | Chloroform           | D042           | 2,4,6-Trichlorophenol        |
| D023           | o-Cresol             | D043           | Vinyl Chloride               |

**TABLE VI: HAZARDOUS WASTE CODES FOR NON-SPECIFIC SOURCES (F001 - F005)**

|   |  |
|---|--|
| F001<br>(Spent individual solvents used in degreasing.) | 1,1,1-trichloroethane, carbon tetrachloride, chlorinated fluorocarbons, methylene chloride, trichloroethylene  |
| F002<br>(Spent individual solvents.)                    | 1,1,1-trichloroethane, 1,1,2-trichloro-1,1,2-trifluoroethane, 1,1,2-trichloroethane, chlorobenzene, methylene chloride, o-dichlorobenzene, tetrachloroethylene, trichlorofluoromethane |
| F003<br>(Spent individual solvents.)                    | Acetone, cyclohexanone, ethyl acetate, ethyl ether, methanol, methyl isobutyl ketone, n-butyl alcohol, xylene  |
| F004<br>(Spent individual solvents.)                    | Cresols, cresylic acid, nitrobenzene   |
| F005<br>(Spent individual solvents.)                    | 2-ethoxyethanol, 2-nitropropene, benzene, carbon disulfide, isobutyl alcohol, methyl ethyl ketone, pyridine, toluene   |

The following F codes listed in 40 CFR 261.31, *Hazardous Waste from Non-Specific Sources*, are also counted as acute hazardous waste unless excluded (see 40 CFR 260.20 and 40 CFR 260.22)

# Standard Operating Procedure

## 2-Mercaptoethanol

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

2-Mercaptoethanol is extremely toxic if swallowed or inhaled and can be fatal if absorbed through the skin. It is corrosive and can cause severe burns to the skin and eyes. It is also a combustible liquid. This compound is extremely toxic to aquatic life and has long-lasting effects in the environment. Additionally, it has an extremely unpleasant odor that can be detected at very low concentrations (stench chemical).

#### Exposure Limits:

OSHA PEL (8 HR. TWA): 0.2 ppm



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of 2-mercaptoethanol must be conducted in a properly functioning chemical fume hood. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended. Wearing two pairs of nitrile gloves is recommended. Contaminated gloves (even just a few drops) must be disposed of as hazardous waste (due to odor). **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** 2-Mercaptoethanol should never be used outside of a chemical fume hood or glove box; therefore respiratory protection should not be required.

## Section 4 – Special Handling and Storage Requirements

- Do not over purchase; only purchase what can be safely stored in the laboratory.
- Avoid contact with skin, eyes, and clothing. Avoid inhalation of vapor or mist.
- Always use inside of a chemical fume hood. 2-Mercaptoethanol has an unpleasant odor at extremely low concentrations. Therefore, extreme care should be taken when handling; always work with under a chemical fume hood.
- Keep container upright and tightly closed in a dry and well-ventilated place. Containers should remain closed when not in use. A vented chemical cabinet or storage fume hood is recommended. Consider using a secondary sealed container (over pack) to minimize odors.
- Containers which are opened must be carefully resealed and kept upright to prevent leakage. If a spill occurs outside of a chemical fume hood, make sure that everyone is aware of the spill and that it is cleaned up immediately. 2-Mercaptoethanol is often mistaken for a natural gas leak, therefore it is extremely important that people are aware of the spill and that it is cleaned up immediately.
- Keep away from incompatible materials: oxidizing agents and metals, such as aluminum, stainless steel, iron and copper.
- Use in the smallest practical quantities for the experiment being performed.
- Containers should be labeled appropriately. Label should indicate the name of the chemical(s) in the container. Avoid using chemical abbreviations (acceptable if a legend is present in the lab) and formulae.

## Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed). 2-Mercaptoethanol has an unpleasant odor at extremely low

concentrations, therefore can be a problem if even a small spill occurs outside of a chemical fume hood. If a small spill occurs that causes an odor issue, open the lab chemical fume hood sashes to maximize flow, leave the lab and make sure the exterior lab door remains closed (do not prop open) to allow proper negative pressure ventilation of the lab.

**Section 6 – Waste Disposal Procedures**

Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended) away from incompatible chemicals such as aqueous solutions. 2-Mercaptoethanol waste has a very unpleasant odor; care should be taken when handling waste solutions as well. If practicable, do not mix 2-mercaptoethanol waste with other organic waste, collect separately if possible. Contaminated debris (e.g., gloves, Kim wipes, etc.) generated while working with 2-mercaptoethanol must also be collected as hazardous waste (due to odor). Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

**Section 7 – Protocol (Add lab specific Protocol here)**

Click here to enter text.

**Section 8 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with 2-mercaptoethanol, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Ammonia

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Ammonia is a compressed gas that is corrosive, toxic if inhaled, toxic to aquatic life, and may explode if heated. Exposure to ammonia gas causes severe skin burns and eye damage. Ammonia is corrosive to the respiratory tract.



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** The use of ammonia must be conducted in a properly-functioning chemical fume hood. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute. Inside the fume hood, keep these materials away from oxidizing agents, acids, and moisture/water.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Gloves must be worn. Nitrile gloves are recommended. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles. Face shield is also recommended.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If ammonia is being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (49-46371) so a respiratory protection analysis can be performed.

#### **Section 4 – Special Handling and Storage Requirements**

- Always wear appropriate PPE when handling. Avoid contact with skin, eyes, and clothing. Avoid inhalation.
- Keep containers tightly closed. Store in a cool, dry and well-ventilated area.
- Incompatible with the following materials: oxidizing materials, bases.
- Contents under pressure
- Cylinders should be stored and upright and secure

#### **Section 5 – Spill and Accident Procedures**

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat building occupants, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**.

#### **Section 6 – Waste Disposal Procedures**

Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended). Ammonia cylinders should be stored away from heat, oxidizers, and bases. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

#### **Section 7 – Protocol/Procedure (Add lab specific Protocol/Procedure here)**

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from PI.

#### **Section 8 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with Ammonia, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**



| <b>Name</b>               | <b>Signature</b> | <b>Date</b>                 |
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# Standard Operating Procedure

## Chloroform

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Chloroform is a carcinogen. It is harmful if swallowed and causes skin irritation, serious eye irritation, and may cause drowsiness or dizziness. Chloroform is suspected of causing cancer and causing genetic defects of unborn children. It may cause damage to organs (liver, kidney) through prolonged or repeated exposure.



#### Exposure Limits:

OSHA PEL (8 HR. TWA): 2 ppm

OSHA Short Term Exposure Limit: 2 ppm

ACGIH TLV/TWA: 10 ppm



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of chloroform should be conducted in a properly functioning chemical fume hood whenever possible. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

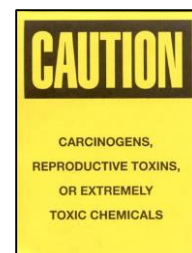
**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. Wearing two pairs of nitrile gloves is recommended. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Flame resistant lab coats must be worn when handling volumes greater than 1 liter. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If chloroform is being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (49-46371) so a respiratory protection analysis can be performed.



## Section 4 – Special Handling and Storage Requirements

- A designated storage area must be established for Chloroform and the area should be posted with a “Caution, Carcinogen, Reproductive Toxins, or Extremely Toxic Chemicals” label provided by REM (as shown to the right).
- Avoid contact with skin and eyes and inhalation.
- Keep containers tightly closed.
- Store in a cool, dry and well-ventilated area away from incompatible substances such as oxidizers.
- Containers which are opened must be carefully resealed and kept upright to prevent leakage.
- A suitable storage location is a flammable storage cabinet or lab cabinet that does not contain incompatibles.

## Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

## Section 6 – Waste Disposal Procedures

Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended). No toxic materials are permitted to be poured down the drain. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link:

<http://www.purdue.edu/epps/rem/hmm/chemwaste.htm>.

## Section 7 – Protocol/Procedure (Additional lab protocol may be added here)

Click here to enter text.

## Section 8 – Documentation of Training (signature of all users is required)

Prior to conducting any work with chloroform, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Diethyl Ether

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |                                |
|--|--------------------------------|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B |
| <b>Department:</b>                           | Chemistry                      |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                  |
| <b>Principal Investigator Signature:</b>     | Click here to enter text.      |

### Section 2 – Hazards

Diethyl ether is an extremely flammable liquid and vapor, forming explosive mixtures with air. The auto-ignition temperature of diethyl ether is 160°C; therefore it can be ignited by a hot surface without flame or spark. If not stored and handled properly, diethyl ether can pose a serious threat to the health and safety of personnel. Diethyl ether is peroxide forming and has the potential to form explosive peroxides; therefore it is a time-sensitive chemical. Refer to REM's Time-Sensitive Chemicals webpage for more specific information (<http://www.purdue.edu/rem/hmm/timesensitive.htm>).



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of diethyl ether should be conducted in a properly functioning chemical fume hood whenever possible. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. Wearing two pairs of nitrile gloves is recommended. If handling a high volume (> 1 liters) of

flammable or combustible liquid, then disposable gloves are likely not suitable; a more heavy duty glove such as a butyl rubber is required.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Flame resistant lab coats must be worn when handling volumes greater than 1 liter. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If diethyl ether is being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (49-46371) so a respiratory protection analysis can be performed.

## Section 4 – Special Handling and Storage Requirements

- Conduct the procedure only after a supervisor has observed the user performing the proper technique unassisted.
- Label all diethyl ether containers with the purchase date and the date opened. Storage time should never exceed the manufacturer's recommendations. The general storage time limit for diethyl ether is 12 months.
- Keep away from sources of ignition. Avoid heat and shock or friction when handling.
- Keep containers tightly closed. Store in a cool, dry and well-ventilated area away from incompatible substances. Store away from light.
- Avoid contact with skin, eyes, and inhalation.
- Diethyl ether must be segregated from incompatible materials such as oxidizers, strong acids, halogens, and sulfur compounds.
- The amount of diethyl ether stored should be kept at an absolute minimum.
- Prevent electric static build-up with a grounding cable when transferring diethyl ether.
- Suitable storage locations include flammable storage cabinets or intrinsically safe refrigerators or freezers.
- Store diethyl ether away from light. Limit exposure to air and other contaminants, specifically heavy metals.
- If possible, only use diethyl ether with inhibitors.



## Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

## Section 6 – Waste Disposal Procedures

Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended). Flammable and combustible liquid waste should be segregated from all incompatibles such as oxidizers. No flammable or combustible liquids (including alcohols) are permitted to be poured down the drain. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/epps/rem/hmm/chemwaste.htm>.

## Section 7 – Protocol (Additional lab protocol may be added here)

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from the Principal Investigator.

## Section 8 – Documentation of Training (signature of all users is required)

Prior to conducting any work with diethyl ether, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Acrylamide Gel

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Unpolymerized powder and solutions of acrylamide should be handled with great care. Wear a labcoat, nitrile gloves and safety goggles and use absorbent bench protectors. Avoid contact of unpolymerized acrylamide solutions with skin; skin contact can cause toxic and systemic effects. Do not inhale acrylamide powder. Avoid handling powder, purchase premixed solutions instead. If powder must be used, a dust mask must be worn. Dispose mask after use. Acrylamide is a suspected carcinogen and neurotoxin, and may cause reproductive toxic effects. Acrylamide is also toxic if swallowed. It is irritating to eyes and skin. It may cause sensitization by inhalation and skin contact and is readily absorbed through skin. The target organs are nerves and kidneys.



#### Toxicological Information:

Skin irritation: 500 mg/24-hrs - mild (rabbit); Eye irritation: 500 mg/24-hrs - moderate (rabbit); Oral LD50: 124 mg/kg (rat); Dermal LD50: 1680 uL/kg (rabbit); Positive in the in vitro chromosome aberration and sister chromatid exchange assays; Negative in the sex-linked recessive lethal assay; Negative to weakly positive in the Ames test; Some evidence of reproductive toxicity noted in multigenerational animal studies including testicular degeneration, reduced sperm motility, and impaired fertility; Monkeys exposed to 10 mg/kg exhibited impaired visual function; Acrylamide has been associated with cancer in animal drinking water studies.

### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Work with acrylamide solutions certified ducted fume hood

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.



**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. Wearing two pairs of nitrile gloves may be recommended.

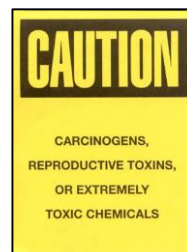
**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If polyacrylamide is being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (49-46371) so a respiratory protection analysis can be performed.

## Section 4 – Special Handling and Storage Requirements

Acrylamide solutions and powder should be stored in dark containers. Acrylamide should always be handled with nitrile gloves, while wearing a labcoat and goggles while working on an absorbent bench liner. If powdered acrylamide is handled, always wear a dust mask (or work in fume hood), gloves, goggles and a labcoat. When working with acrylamide, the area must be labeled with a sign stating “CAUTION, CANCER HAZARD -SELECT CARCINOGEN”. The storage space (i.e. refrigerator) must also have a similar label, and acrylamide must be stored in a secondary container.



## Section 5 – Spill and Accident Procedures

If you accidentally spill liquid on your skin, immediately wash area with water and soap, seek medical attention if irritation or concern.

For liquid spills use absorbent powder from the spill kit. Place contaminated powder into a container for disposal with REM. Treat spill site with 1.6% potassium persulfate, then with 1.6 % sodium metabisulfite. Let stand for 30 minutes, and then wash with plenty of water.

In case of a dry spill scrape material into a clean container without creating airborne dust. Treat site with 1.6% potassium persulfate, then with 1.6 % sodium metabisulfite. Let stand for 30 minutes, then wash with plenty of water.

## Section 6 – Waste Disposal Procedures

Dispose both unpolymerized and polymerized acrylamide through REM as hazardous waste. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

**Section 7 – Protocol (Additional lab protocol may be added here)**

| Process Steps  | Safety Measures   |
|--|---|
| Pouring gels for electrophoresis.                                      | Wear nitrile gloves, a labcoat, goggles, and use absorbent bench liner. |
| Handling of polymerized gels for Western Blot Analysis.                | Wear nitrile gloves.  |
| Disposal of polymerized and unpolymerized acrylamide through EHS only. |   |

**Section 8 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with polyacrylamide, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Acutely Toxic Materials, Reproductive Toxic Materials, Target Organ Toxics, and Carcinogens

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Important Definitions

- **Lethal Dose-50 (LD50):** The amount of a substance that, when administered to a group of experimental animals, will kill 50% of the group in a specified time.
- **Lethal Concentration-50 (LC50):** The concentration of a substance that, when administered to a group of experimental animals, will kill 50% of the group in a specified time.
- **Permissible Exposure Limit (PEL):** The maximum amount or concentration of a chemical that a worker may be exposed to under OSHA regulations. PELs are based on an 8-hour time weighted average (TWA) exposure.
- **Immediately Dangerous to Life and Health (IDLH):** The airborne concentration of a contaminant that poses an immediate threat to life and health likely to cause death of immediate or delayed permanent adverse health effects or prevent escape from such an environment.
- **Acutely Toxic Material:** Substances that may be fatal or cause damage to target organs as the result of a single exposure or exposure of short duration. Acute toxins are quantified by substance's LD50 or LC50.
- **Reproductive Toxic Material:** Substances that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogens).
- **Target Organ Toxic Material:** Substances that pose adverse health effects to specific organs such as the liver, kidneys, lungs, etc.
- **Carcinogen:** A chemical is considered to be a carcinogen if:
  - It has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen; or
  - It is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (Latest edition); or
  - It is regulated by OSHA as a carcinogen.
- **Toxic Chemical:** A chemical falling within any of the following categories:
  - A chemical that has a median lethal dose (LD50) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
  - A chemical that has a median lethal dose (LD50) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact

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

### Section 3 – Hazards

These substances are highly toxic by inhalation, ingestion, or skin absorption. Many acutely toxic chemicals are also carcinogenic and may have other hazards such as target organ effect, pose an environmental hazard, and/or corrosivity, etc. Make sure that all of the potential hazards are clearly understood before handling any toxic chemical.



### Section 4 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of acutely toxic materials must be conducted in a properly functioning chemical fume. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. Wearing two pairs of nitrile gloves is recommended. It is critical that the glove being worn is resistant to the particular acutely toxic chemical. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

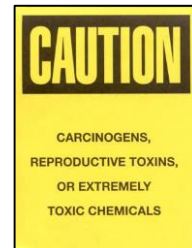
**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Flame resistant lab coats must be worn when handling volumes greater than 1 liter. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If toxic materials are being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (49-46371) so a respiratory protection analysis can be performed.

## Section 5 – Special Handling and Storage Requirements

- A designated storage area must be established for acutely toxic chemicals and the area should be posted with a “Caution, Carcinogen, Reproductive Toxins, or Extremely Toxic Chemicals” label provided by REM (as shown to the right).
- Suitable storage locations include lab cabinets, desiccators, glove boxes, flammable storage cabinets that do not contain incompatible chemicals (primarily strong acids), or non-domestic refrigerators or freezers.
- Acutely toxic materials should be stored in secondary containment at all times as a precautionary measure. If possible, store all acutely toxic materials in a dedicated cabinet. Consider placing all acutely toxic chemicals in secondary containment (e.g., plastic bin). Signs should be posted to indicate their presence and unique hazards.
- A current copy of the SDS for the specific acutely toxic chemical(s) being used must be made available to all personnel working in the laboratory at all times.
- The amount of acutely toxic material stored in the lab should be kept at a minimum. Any expired or unnecessary materials should be properly disposed of as hazardous waste.
- All acutely toxic materials should be clearly labeled with the original manufacturer’s label, which should have the chemical name, hazard labels, and pictograms. The label should not be defaced in any way.
- Do not over purchase; only purchase what can be safely stored in the laboratory.
- Avoid contact with skin, eyes, and inhalation.
- Keep away from sources of ignition.
- Keep containers tightly closed. Store in a cool, dry, and well-ventilated area away from incompatible substances such as strong acids.



## Section 6 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

## Section 7 – Waste Disposal Procedures

All acutely toxic chemical waste must be collected for proper waste disposal by REM (sink disposal is not permitted). Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended). No toxic materials are permitted to be poured down the drain. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

**Section 8 – Protocol/Procedure (Additional lab protocol may be added here)**

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from Principal Investigator.

**Section 9 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with acutely toxic materials, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
|---------------------------|-----------|-----------------------------|
| Click here to enter text. |           | Click here to enter a date. |
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# Standard Operating Procedure

## Biosafety Level 2

### Section 1 – Lab-Specific Information

|   |   |
|---|---|
| <b>Department:</b>                                  | Chemistry   |
| <b>Date SOP was written:</b>                        | 2/1/2016  |
| <b>Date SOP was approved by PI/lab supervisor:</b>  | Click here to enter a date.                                     |
| <b>Principal Investigator:</b>                      | Gaurav Chopra   |
| <b>Internal Lab Safety Coordinator/Lab Manager:</b> | Click here to enter text.                                       |
| <b>Lab Phone:</b>                                   | 496-6617  |
| <b>Office Phone:</b>                                | Click here to enter text.                                       |
| <b>Emergency Contact:</b>                           | Click here to enter text.<br><i>(Name and Phone Number)</i>     |
| <b>Location(s) covered by this SOP:</b>             | DRUG 210,210A, 201B, 274, 274B<br><i>(Building/Room Number)</i> |
| <b>Biohazardous Agents covered by this SOP:</b>     | Click here to enter text.                                       |

### Section 2 – Type of SOP:

Process
  Biosafety Procedure
  Hazardous Class

### Section 3 – Biosafety Level 2 Requirements

- Laboratory personnel have specific training in handling pathogenic agents and are supervised by scientists competent in handling infectious agents and associated procedures; access to the laboratory is restricted when work is being conducted; and all procedures in which infectious aerosols or splashes may be created are conducted in a biosafety cabinet (IIA2 or IIB2) or other physical containment equipment.
- The laboratory supervisor must enforce the institutional procedures that control access to the laboratory.

- Lab staff must wash their hands after working with potentially hazardous materials and before leaving the laboratory.
- Eating, drinking, smoking, handling contact lenses, applying cosmetics, and storing food for human consumption is not be permitted in laboratory areas. Food must be stored outside the laboratory area in cabinets or refrigerators designated and used for this purpose.
- Mouth pipetting is prohibited; mechanical pipetting devices must be used.
- Perform all procedures to minimize the creation of splashes and/or aerosols.
- Plastic ware should be substituted for glassware whenever possible.
- An effective integrated pest management program is required.
- Animal and plants not associated with the work being performed must not be permitted in the laboratory.
- An eyewash station must be readily available.

#### **Section 4 – Agent Awareness**

Review the REM supplied agent risk assessment with all staff that will be exposed either through direct handling or proximity. Signs and symptoms, transmission routes, personal protective equipment, decontamination, and accident/exposure information will be covered.

All laboratory personnel and particularly women of childbearing age should be provided with information regarding immune competence and conditions that may predispose them to infection. Individuals having these conditions should be encouraged to self-identify to the institution's healthcare provider for appropriate counseling and guidance.

The laboratory supervisor must ensure that laboratory personnel receive appropriate training regarding their duties and demonstrate proficiency in standard and special microbiological practices before working with BSL2 agents.

Personnel must receive annual updates or additional training new biohazards are added or other lab changes occur.

All persons entering the laboratory must be advised of the potential hazards and meet specific personal protection requirements.



## Section 5 – Personal Protective Equipment (PPE)

At a minimum, gloves, outerwear (single use when directly handling high hazards), eye protection, and if necessary respiratory protection (a fit tested N-95 mask, higher level respiratory protective devices may be recommended depending of the protocol risk assessment).

The laboratory supervisor must ensure that laboratory personnel receive appropriate training regarding biohazardous agents, the tasks that involve handling or exposure to biohazards, the type of required personal protective equipment, and demonstrate proficiency in utilizing this equipment.

Lab staff must receive annual updates or additional training when procedures or hazards change.

Protective laboratory coats, gowns, smocks, or uniforms designated for laboratory use must be worn while working with hazardous materials. Remove protective clothing before leaving for non-laboratory areas. Do not take laboratory clothing home for washing.

Eye and face protection (goggles, face shield or other splatter guard) is used for anticipated splashes or sprays of infectious or other hazardous materials when the microorganisms must be handled outside the Biosafety Cabinet or containment device.

Persons who wear contact lenses in laboratories should also wear eye protection.

Latex exam gloves, synthetic rubber, nitrile, vinyl, or neoprene also provide acceptable barrier protection against biological hazards. Nitrile glove are preferred as they protect against bio-agents, chemical exposure\*, and reduce the potential for allergic reaction. \*Refer to glove selection chart if chemicals will be used:

[http://www.ansellpro.com/download/Ansell\\_8thEditionChemicalResistanceGuide.pdf](http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf)

- Gloves must be worn to protect hands from exposure to hazardous materials. Glove selection should be based on an appropriate risk assessment.
- Change gloves when contaminated or if glove integrity is compromised. Remove gloves and wash hands when work with hazardous materials has been completed and before leaving the laboratory. Do not wash or reuse disposable gloves. Dispose used gloves with other contaminated laboratory waste.
- Gloves must not be worn outside the laboratory.

Respirator type is determined by risk assessment and/or REM recommendation. Lab personnel intending to use/wear a respirator mask must participate in the Biological Exposure Occupational Health Program and be trained and fit-tested by REM.

## **Section 6 – Biosafety Cabinets and Engineering Controls**

All procedures involving the manipulation of infectious materials that may generate an aerosol will be conducted within a Class II Biosafety Cabinet (BSC), with appropriate personal protective equipment, physical containment devices, or other physical containment devices. Aerosols may include pipetting, centrifuging, grinding, blending, shaking, mixing, sonicating, opening containers of infectious materials, inoculating animals, and harvesting infected tissues from animals or eggs.

Infectious agents will be centrifuged inside a BSC or, if in the open laboratory, by using sealed rotor heads or centrifuge safety cups. Vacuum lines should be protected with liquid disinfectant traps and inline HEPA filters.

BSCs must be installed so that fluctuations of the room air supply and exhaust do not interfere with proper operations. BSCs should be located away from doors, windows that can be opened, heavily traveled laboratory areas, and other possible airflow disruptions. REM will offer guidance: <http://www.purdue.edu/rem/eh/bsclfcb.htm>

## **Section 7 – Biohazard Exposure Occupational Health Program and Exposure**

The Purdue University Biological Exposure Occupational Health Program provides awareness training and/or review, handling information, and medical oversight to anyone at Purdue University working with a Risk Group 2 or higher biological agent (BSL 2 or higher laboratory). Program participation is offered at no charge. Participation includes a risk assessment, agent specific exposure awareness review, and a medical assessment. Individual risk assessments and exposure potentials will be reviewed by medical personnel to determine if vaccinations, serum testing, or pre -exposure baseline sample collection is warranted. When necessary, any post exposure accident information will be available as well.

Incidents that may result in exposure to infectious materials must be reported to the laboratory supervisor, the University Biosafety Officer, and a First Report of Injury must be submitted as soon as possible. Medical evaluation, surveillance, and treatment will be provided.

## Section 8 – Sharps

Purdue Universities Sharps and Infectious Waste Handling procedure will be followed:

<http://www.purdue.edu/rem/home/booklets/sharps.pdf>

Sharps are items that are capable of puncturing, cutting, or abrading the skin: glass and plastic pipettes, broken glass, test tubes, petri dishes, razor blades, needles, syringe with needle. Careful management of needles and other sharps are of primary importance. Needles must not be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal. Lab staff that routinely works with sharps and handle sharps waste should use appropriate personal protective equipment, tools, barrier protection, or engineering controls to protect themselves.

## Section 9 – Decontamination

Laboratory wastes will be decontaminated by autoclave, chemical disinfection, incineration, or other validated decontamination method.

Decontaminate work surfaces after completion of work and after any spill or splash of potentially infectious material with 10% bleach solution or 70% ethanol or other appropriate disinfectant.

Decontaminate all cultures, stocks, and other potentially infectious materials before disposal.

Materials to be decontaminated outside of the immediate laboratory must be placed in an autoclavable biohazard bag and kept secured until decontaminated.

Equipment must be decontaminated before repair, maintenance, or removal from the laboratory.

Decontaminate all spills, equipment, counters, and other surfaces. A 10% bleach solution or 70% ethanol can be used to disinfect and a strong detergent and water rinse may remove most drug residues. Repeating the cleaning steps will provide additional drug removal.

Decontamination materials need to be available in case of a spill during transportation.

## **Section 10 – Medical Emergency**

### **Life Threatening Emergency, After Hours, Weekends And Holidays: Dial 911.**

All employees, whether undergrad, grad, part-time or full-time must go to IU Health Arnett Occupational Health Center, Unity Healthcare's Regional Occupational Care Center (ROCC), or one of the emergency rooms (if emergency room is required). Purdue University Student Health (PUSH) and the Center for Healthy Living should not to be used for ANY employee injury. Report the incident to the Biosafety Officer as soon as possible.

Immediately report injury to supervisor and complete the First Report of Injury.

(<http://www.purdue.edu/rem/injury/froi.htm>)

## **Section 11 – Waste Disposal Procedures**

Biological waste must be managed separately from chemical waste. The most common example where chemical waste is mistaken for biological waste is agarose gel contaminated with ethidium bromide or heavy metals (i.e. arsenic, chromium). This type of material should always be managed as chemical waste. When both chemical and biological waste types exist, the biological agent(s) should be treated first. Once the biological agents have been deactivated by either autoclave or chemical disinfection, the remaining chemical waste should be submitted on a Hazardous Materials Pickup Request Form:

<http://www.purdue.edu/rem/home/files/forms.htm#HMM001>

## **Section 12 – Sharing Biological Agents or Material and Lab Security**

### **Sharing Biological Agents**

Sharing of bio-agents or materials with colleagues promotes and facilitates research, but doing so without institutional oversight could result in safety and regulatory problems. Certain biohazardous agents are closely regulated by the Department of Commerce, Centers for Disease Control, the Animal Plant Health Inspection Service, National Institutes of Health, as well as Purdue University.

It is important that the IBC be made aware of bio-agent sharing prior to the transfer. The IBC will check protocol approvals (IBC, PACUC, and IRB), material transfer agreements, initiate protocol amendments, review bio-agent related training, and discuss specific handling procedures, i.e., labeling, packaging, and shipping. Notifiable bio-agents and materials include:

- Risk Group 2 or above biohazardous agents;
- Human cell lines, unfixed blood, tissue, or fluids; and
- Recombinant or synthetic nucleic acid molecules.

### **Laboratory Security**

All laboratory personnel have a responsibility to protect university property from misuse and theft of hazardous materials, particularly those that could threaten human health. At a minimum, the following security measures should be employed in all campus laboratories:

- The laboratory door must remain locked when not occupied; even for short periods of time.
- Always feel free to question anyone that enters the lab that you do not know and ask to see identification if necessary.
- If you see anything suspicious or someone displays suspicious behavior, immediately report it to the Purdue Police Department by dialing 911 (emergency) or (765) 494-8221 (non-emergency).
- Any sensitive information or particularly hazardous biological agents should not be stored out in the open where anyone can readily have access to them. These types of materials must be stored in a secure location and lab personnel must be present when these materials are in use.

### **Section 13 – Documentation of Training (signature of all users is required)**

- Prior to conducting any work in the BSL2 laboratory, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the Safety Data Sheet provided by the manufacturer.
- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training annually.

### **Section 14 – Institutional Biosafety Committee**

If your IBC related research expands or changes beyond the current protocol description, an amendment describing the changes must be submitted to the Biosafety Officer. For example, if new biohazardous agents are to be added, changes in lab staff, collaborations with other labs, and/or processes that require higher containment. IBC form 2A:

<http://www.purdue.edu/research/vpr/rschadmin/rschoversight/rdna/forms.php>

**I have read and understand the content of this SOP:**

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# Standard Operating Procedure

## Compressed Gases

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Contains gas under pressure; may explode if heated. Protect from sunlight. Gases may displace oxygen and present an asphyxiation hazard. Many gases present other hazards (i.e., flammable, reactive, cryogenic, etc.); make sure that all of the potential hazards are understood before handling any chemical. Compressed gas cylinders are often very heavy and present physical hazards such as crushing of feet, hands, etc. Extreme care must be used when handling compressed gas cylinders.



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of compressed gases must be conducted in well ventilated areas that are appropriate for chemical use. Contact REM for information regarding specific handling requirements when work with toxic, highly toxic, corrosive, and reactive gases. Generally, these types of gases need to be stored and used with local exhaust ventilation (e.g., fume hood or gas cylinder cabinet).

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling. Take precautions to avoid exposure, both acute and chronic. Ensure that all gas handling protocols are being followed when handling.

**Hand Protection:** Chemical-resistant gloves must be worn. Disposable nitrile gloves are recommended. If moving large compressed gas cylinders, leather gloves or something comparable should be worn. If handling cryogenic gases, appropriate cryogenic gloves must be worn. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact. Gloves should be changed prior to touching paperwork or common work surfaces (i.e., keyboards, phones, doorknobs, etc.) or paperwork.

**NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length (flame resistant lab coats must be worn if handling flammable gases such as hydrogen). Laboratory coat sleeves must be of sufficient length to prevent skin exposure while wearing gloves. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** Respiratory protection is not generally required when working with compressed gases. However, if working with an acutely toxic gas, even if it is being used in a chemical fume hood, contact REM(49-46371) so a respiratory protection evaluation can be performed.

## Section 4 – Special Handling and Storage Requirements

- Compressed gas cylinders should be stored in a secure, well ventilated location, and in an upright position at all times.
- All compressed gas cylinders should be handled as if full and should never be completely emptied.
- Cylinders that are not in use (meaning that the regulator is not attached) must be secured and the safety cap must be on the cylinder and are permitted to be chained together as shown below in Figure 1.
- Cylinders that are in use, meaning there is a regulator attached, must be individually secured by a chain or strap as shown below in Figure 2.
- Cylinder valves and regulators must be protected from impact or damage.
- A designated storage area must be established for compressed gases.
- Toxic, highly toxic, corrosive, and reactive gases should be stored in a gas cylinder cabinet as shown in Figure 3.
- Do not over purchase; only purchase what can be safely stored in the laboratory.
- Avoid contact with skin, eyes, and inhalation.
- Keep away from sources of ignition if the gas is flammable.





Figure 1: Not In-Use Cylinders



Figure 2: In-Use Cylinders



Figure 3: Gas Cylinder Cabinet

- Follow laboratory supervisor's instructions for PPE, which may differ depending on the type and/or quantity of compressed gas being used.
- Use in the smallest practical quantities for the experiment being performed.
- Work must be conducted in a chemical fume hood if air concentrations above 10% of the LEL could be created, if the chemical is irritating to the eyes or respiratory system, and/or is toxic by inhalation.
- Gas cylinder connections and fittings must be inspected frequently for deterioration and must never be used without a regulator.
- Never use a leaking, corroded, or damaged cylinder and never refill compressed gas cylinders.
- When stopping a leak between cylinder and regulator, always close the valve before tightening the union nut.
- The regulator should be replaced with a safety cap when the cylinder is not in use.
- The safety cap must be in place when a gas cylinder is moved.
- For large gas cylinders (>27 inches), an approved gas cylinder cart should be used. The cylinder must be strapped to the cart and the protective cap must be in place before moving the cylinder. A cylinder should never be moved or transported without the protective cap. The proper way to move a large gas cylinder is illustrated in Figure 4.
- A few compressed gas cylinders have a shelf-life and can become more hazardous as time goes on. It is extremely important that these chemicals are identified and managed properly. If any time-sensitive gases are found to be past the manufacturer's expiration date, they must be submitted to REM for hazardous waste disposal immediately. The following is a list of time-sensitive compressed gases:
  - Hydrogen fluoride, anhydrous
  - Hydrogen bromide, anhydrous
  - Hydrogen sulfide, anhydrous
  - Hydrogen cyanide, anhydrous
  - Hydrogen chloride, anhydrous



Figure 4: Cylinder Cart

## Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the release. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the release is minor and does not pose a threat to personnel, contact REM at 49-

40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for assistance (dial 911 if release occurs after hours and assistance is needed).

## Section 6 – Waste Disposal Procedures

Before submitting compressed gas waste to REM, ensure that the cylinder cannot be returned to the manufacturer or distributor. Many gas vendors charge demurrage for gas storage. Most lecture bottles cannot be returned to the manufacturer and must be treated as waste. Store hazardous waste in closed containers that are properly labeled, and in a designated area. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM (even if the compressed gas cylinder is empty – never remove the valve from a cylinder for disposal purposes); detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

## Section 7 – Protocol/Procedure (Add lab specific Protocol/Procedure here)

Click here to enter text.

## Section 8 – Documentation of Training (signature of all users is required)

Prior to conducting any work with compressed gases, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Corrosives

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Important Definitions

- **Acid:** Any chemical compound which, when dissolved in water, gives a solution with a pH of less than 7.0.
- **Mineral Acid:** A compound having atoms of hydrogen, identifying nonmetal (typically chlorine, sulfur, or phosphorus), and maybe oxygen. Sulfuric acid ( $\text{H}_2\text{SO}_4$ ) and hydrochloric acid (HCl) are examples of mineral acids.
- **Organic Acid:** An organic compound with acidic properties. Generally, organic acids are also flammable. Acetic acid ( $\text{CH}_3\text{COOH}$ ) and Formic acid ( $\text{HCOOH}$ ) are examples of organic acids.
- **Base:** Any chemical compound which, when dissolved in water, gives a solution with a pH of greater than 7.0.

### Section 3 – Hazards

Corrosives may be harmful if inhaled, ingested, or absorbed through the skin. Inhalation may cause irritation to the respiratory tract with burning pain in the nose and throat, coughing, wheezing, shortness of breath and pulmonary edema. Contact with skin causes burns and irritation. Eye contact causes burns, irritation, a may cause blindness. Ingestion may cause permanent damage to the digestive tract. It is destructive to the tissue of the mucous membranes and upper respiratory tract. Acids and bases may have other hazards associated with them, such as flammability, oxidizer, or toxicity. Note: Refer to SOP of Hydrofluoric acid (HF) for specific hazards and safety information.



## Section 4 – Engineering and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of corrosive materials should be conducted in a properly functioning chemical fume hood whenever possible. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. For high volume applications, disposable gloves are not appropriate; a heavy-duty glove is required such as butyl rubber, Viton, or equivalent. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may be required for high volume applications.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. For high volume applications, additional PPE such as a chemical-resistant apron may be required. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If corrosive materials are being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (49-46371) so a respiratory protection analysis can be performed.

## Section 5 – Special Handling and Storage Requirements

- Do not over purchase; only purchase what can be safely stored in the laboratory.
- Avoid contact with skin and eyes. Avoid inhalation of vapor or mist. Avoid formation of dust.
- Always use inside a properly functioning chemical fume hood.
- **Note:** In case you need to dilute the concentration of acids, always add acid to water.
- Keep container upright and tightly closed in a dry and well-ventilated place.
- Containers which are opened must be carefully resealed and kept upright to prevent leakage.
- Keep away from sources of ignition. Avoid heat and shock or friction when handling.
- Store in original container. Acids should not be stored in metal containers.
- Keep away from incompatible materials. Acids and bases should not be stored together. Organic acids and oxidizing acids must be stored separately or with proper secondary containment (see below).
- Use in the smallest practical quantities for the experiment being performed.
- Work must be conducted in a chemical fume hood if the chemical is irritating to the eyes or respiratory system, and/or is toxic by inhalation.
- A current copy of the SDS for the specific toxic chemical being used must be made available to all personnel working in the laboratory at all times.



Demonstration of proper use of secondary containment with Organic and Oxidizing acids

- Containers should remain closed when not in use.
- Containers should be labeled appropriately. Label should indicate the name of the chemical(s) in the container. Avoid using chemical abbreviations (acceptable if a legend is present in the lab) and formulae.
- Containers should be in good condition and compatible with the material.
- Transport all corrosives in secondary containment, such as polyethylene or other non-reactive acid/solvent bottle carrier.
- Corrosives must be segregated from incompatible materials. Incompatibilities will be noted in Section 10 of the SDS, "Stability and Reactivity".

## Section 6 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

## Section 7 – Waste Disposal Procedures

Store hazardous waste in closed containers that are properly labeled, and in a designated area. Corrosive waste should be segregated from all incompatibles (e.g., acids away from bases). No corrosive wastes are permitted to be poured down the drain. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/epps/rem/hmm/chemwaste.htm>.

## Section 8 – Protocol (Additional lab protocol may be added here)

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from Principal Investigator.

**Section 9 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with formaldehyde, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Ethidium Bromide

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol is added to the protocol section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 –Hazards

Ethidium bromide is classified by OSHA as highly toxic by inhalation, harmful by ingestion, and a mutagen. Avoid breathing dust, fumes, gas, vapor, mist, or spray. Toxic if inhaled. Ethidium bromide is suspected of causing genetic defects.



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Under normal working conditions where ethidium bromide is in very low concentrations in agarose gel or in an aqueous solution, use in chemical fume hood is not required, but recommended. However, all ethidium bromide powder (pure product) must be handled in a properly functioning chemical fume hood. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

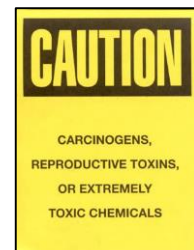
**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended. Wearing two pairs of nitrile gloves is recommended. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** Under normal working conditions where ethidium bromide is in very low concentrations in agarose gel or in an aqueous solution, respiratory protection is not required. However, all ethidium bromide powder (pure product) must be handled in a properly functioning chemical fume hood.



## Section 4 – Special Handling and Storage Requirements

- Designate an area where ethidium bromide work is going to occur and only handle it in this area (i.e. chemical fume hood, bench top). The area should be posted with a “Caution, Carcinogen, Reproductive Toxins, or Extremely Toxic Chemicals” label provided by REM (as shown to the right).
- A current copy of the SDS for the specific ethidium bromide powder or solution and concentration must be made available to all personnel working in the laboratory at all times.
- It is recommended that the surfaces of the designated area be covered with an appropriate liner (i.e. plastic, chemical resistant liner). If the liner becomes contaminated, it can be replaced and disposed of as ethidium bromide contaminated debris.
- If a liner cannot be used, then the surfaces of the work area should be decontaminated routinely. All spills or evidence of contamination should be cleaned immediately.
- Avoid contact with skin and eyes and inhalation.
- Keep containers tightly closed.
- Store in a cool, dry and well-ventilated area.
- Containers which are opened must be carefully resealed and kept upright to prevent leakage.
- Routinely decontaminate the area where ethidium bromide is used. Decontamination procedures are detailed below:

### Decontamination Procedures:

- Prepare the following decontamination solution:
  - 4.2 grams of sodium nitrite ( $\text{NaNO}_2$ )
  - 20 milliliters of 50% hypophosphorous acid solution ( $\text{H}_3\text{PO}_2$ )
  - 300 milliliters of water
- Soak a paper towel in the decontamination solution and thoroughly wash the contaminated area.



- Once the contaminated area has been thoroughly washed with the decontamination solution, rinse the area 5 times with tap water using a clean paper towel for each rinse.
- Soak all spent paper towels in the decontamination solution for one hour. Gently wring out excess solution and dispose of as hazardous waste with contaminated gloves, pipette tips or any other solid ethidium bromide debris.
- Using a UV light, check to ensure all ethidium bromide has been removed.
- The decontamination solution should be collected in an appropriate container and labeled as hazardous waste (i.e. Water 95%, hypophosphorus acid 3%, Sodium Nitrite 1%, ethidium Bromide 1%).

**Note:** Hypophosphorous acid is a DEA List chemical. When purchasing this product, you and your PI will have to fill out and sign an “Authorized Purchaser” form. This is simply a company’s method of ensuring you will not misuse the material.

## Section 5 – Spill and Accident Procedures

Immediately isolate the area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed). If lab personnel feel comfortable cleaning up the spill, then they can do so as long as proper training has been provided. The spilled material should be absorbed and/or collected and put in an appropriate container (e.g., bucket and/or bag) for proper disposal by REM. The decontamination procedures detailed in Section 4 of this SOP should be followed for decontaminating surfaces.

## Section 6 – Waste Disposal Procedures

Ethidium bromide waste must be collected and managed as hazardous waste, not biological waste. PPE, absorbent materials, liners or other debris contaminated with ethidium bromide must also be collected as hazardous waste. All solid ethidium bromide waste, including debris and dry agarose gels, should be placed in an appropriate container and labeled accordingly. Please double-bag solid waste in two black trash bags. Do not use orange biohazard waste bags unless the waste is also infectious (biohazard). The buffers and solutions used with ethidium bromide gels can be submitted to REM as chemical waste or put down the drain only if a filter especially designed for removal of ethidium bromide is used. There are several commercially available filtering systems that can be purchased. One such product can be found at the following link: [http://www.thomasci.com/Supplies/Filtering-Funnels/\\_Extractor-EtBr-Waste-Reduction-System/](http://www.thomasci.com/Supplies/Filtering-Funnels/_Extractor-EtBr-Waste-Reduction-System/). Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

## Section 7 – Protocol (Additional lab protocol may be added here)

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from the Principal Investigator

**Section 8 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with formaldehyde, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
|---------------------------|-----------|-----------------------------|
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# Standard Operating Procedure

## Flammable and Combustible Liquids

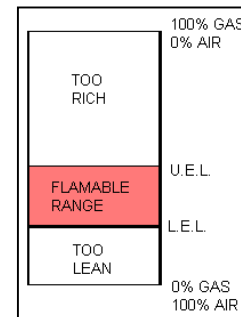
**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol is added to the protocol section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Important Definitions

- **Flammable Liquid:** Liquids having a flash point below 38°C (100°F).
- **Combustible Liquid:** Liquids having a flash point at or above 38°C (100°F) and no greater than 93°C (200°F).
- **Flash Point:** The minimum temperature at which vapors are formed on the surface of a substance in sufficient quantity to ignite when exposed to an ignition source.
- **Fire Point:** The minimum temperature at which self-sustained combustion of a substance will occur upon or after exposure to an ignition source.
- **Boiling Point:** The temperature at which the vapor pressure of a liquid equals the atmospheric pressure and the liquid changes into a vapor.
- **Auto Ignition Temperature:** The minimum temperature at which self-sustained combustion will occur in the absence of an ignition source.
- **Lower Explosive Limit (LEL):** The lowest concentration (percentage) of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat).
- **Upper Explosive Limit (UEL):** Highest concentration (percentage) of a gas or a vapor in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat).



### Section 3 – Hazards

Keep flammable or combustible liquid away from heat, sparks, open flames, and hot surfaces. Flammable and combustible liquids often have other hazards associated with them such as toxicity and the ability to form explosive organic peroxides. Make sure that all of the potential hazards are understood before handling any chemical.



## Section 4 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of flammable and combustible liquids should be conducted in a properly functioning chemical fume hood whenever possible. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. Wearing two pairs of nitrile gloves is recommended. If handling a high volume (> 1 liters) of flammable or combustible liquid, then disposable gloves are likely not suitable; a more heavy duty glove such as a butyl rubber is required. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Flame resistant lab coats must be worn when handling volumes greater than 1 liter. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If flammable and/or combustible liquids are being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (49-46371) so a respiratory protection analysis can be performed.

## Section 5 – Special Handling and Storage Requirements

- A designated storage area must be established for flammable and combustible liquids such as a flammable storage cabinet (as shown to the right).
- No more than 37 liters (10 gallons) of flammable liquid is permitted to be stored outside of a flammable storage cabinet/area.
- A current copy of the SDS for the specific flammable/combustible liquids being used must be made available to all personnel working in the laboratory at all times.
- Do not over purchase; only purchase what can be safely stored in the laboratory.
- Avoid contact with skin, eyes, and inhalation.
- Keep away from sources of ignition.
- Keep containers tightly closed. Store in a cool, dry, and well-ventilated area away from incompatible substances such as oxidizers.
- Follow laboratory supervisor's instructions for PPE, which may differ depending on the type and/or quantity of flammable/combustible liquid being used.
- Use in the smallest practical quantities for the experiment being performed.



- Work must be conducted in a chemical fume hood if air concentrations above 10% of the LEL could be created, if the chemical is irritating to the eyes or respiratory system, and/or is toxic by inhalation.
- Containers should remain closed when not in use. This is to prevent accumulation of flammable vapor concentrations and accidental ignition.
- Containers should be labeled appropriately. Label should indicate the name of the chemical(s) in the container. Avoid using chemical abbreviations (acceptable if a legend is present in the lab) and formulae.
- When not in use, store in flammable storage cabinets if possible.
- Containers should be in good condition and compatible with the material; store in safety cans (spring closing lid, as illustrated to the right) if possible.
- Avoid using ignition sources (flame burners or any open flame source, hot plates, electrical equipment with frayed or cracked wiring, etc.) and/or creating static electricity in areas where flammable/combustible chemicals are being used.
- Ground and bond containers when transferring more than 4 liters of flammable/combustible liquids.
- Transport all flammable/combustible liquids in secondary containment, such as polyethylene or other non-reactive acid/solvent bottle carrier.
- Flammable/combustible liquids must be segregated from incompatible materials such as oxidizers (e.g., hydrogen peroxide, nitric acid). Incompatibilities will be noted in Section 10 of the SDS, "Stability and Reactivity".
- If flammable liquids will be stored in refrigerators or freezers, these will be specially modified or purpose-made "flammable-safe" refrigerators and freezers which have no internal sources of ignition posed by an internal light or thermostat circuit.



## Section 6 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

## Section 7 – Waste Disposal Procedures

Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended). Flammable and combustible liquid waste should be segregated from all incompatibles such as oxidizers. No flammable or combustible liquids (including alcohols) are permitted to be poured down the drain. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/epps/rem/hmm/chemwaste.htm>.

## Section 8 – Protocol (Additional lab protocol may be added here)

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from the Principal Investigator.

**Section 9 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with flammable/combustible liquids, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Formaldehyde Solution

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol is added to the protocol section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Formaldehyde is classified by OSHA as a combustible liquid, target organ effect, toxic by inhalation, toxic by ingestion, toxic by skin absorption, skin sensitizer, corrosive, and carcinogen. Do not breathe dust, fumes, gas, vapor, mist, or spray. Toxic if inhaled. Material is extremely destructive to the tissues of the mucous membranes and upper respiratory tract. Causes eye burns. Approximately 1.5 grams of vaporized Formaldehyde will achieve this concentration in a typical laboratory setting. The odor threshold of formaldehyde is reported to be as low as 0.1 ppm.

#### Exposure Limits:

OSHA PEL (8 HR. TWA): 0.75 ppm

OSHA Short Term Exposure Limit: 2 ppm

ACGIH TLV/TWA: 0.3 ppm



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of formaldehyde should be conducted in a properly functioning chemical fume hood whenever possible. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

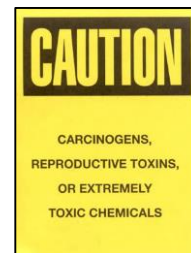
**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. Wearing two pairs of nitrile gloves is recommended. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Flame resistant lab coats must be worn when handling volumes greater than 1 liter. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If formaldehyde is being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (49-46371) so a respiratory protection analysis can be performed.



## Section 4 – Special Handling and Storage Requirements

- A designated storage area must be established for formaldehyde and the area should be posted with a “Caution, Carcinogen, Reproductive Toxins, or Extremely Toxic Chemicals” label provided by REM (as shown to the right).
- Avoid contact with skin and eyes and inhalation.
- Keep away from sources of ignition.
- Keep containers tightly closed.
- Store in a cool, dry and well-ventilated area away from incompatible substances such as oxidizers.
- A suitable storage location is a flammable storage cabinet that does not contain incompatibles.

## Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

## Section 6 – Waste Disposal Procedures

Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended). Formaldehyde waste should be segregated from all incompatibles such as oxidizers. No



flammable or combustible liquids (including alcohols) are permitted to be poured down the drain. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

**Section 7 – Protocol (Additional lab protocol may be added here)**

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from the Principal Investigator.

**Section 8 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with formaldehyde, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Hydrogen Gas

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Hydrogen gas is an extremely flammable compressed gas and can combust in the presence of any oxidizing agent. Containers may rupture or explode if exposed to heat. It is highly recommended that oxygen cylinders in storage be separated from hydrogen or other fuel-gas cylinders or combustible materials (especially oil or grease) by a minimum distance of 20 feet or by a non-combustible barrier at least five feet high and with a fire resistance rating of least one-half hour. Furthermore, the barrier should be at least 18 inches above the tallest cylinder. In simple words, DO NOT store Hydrogen & Oxygen/other oxidizing gases, oxidizing materials together.



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of hydrogen gas must be conducted in a properly functioning gas cabinet or chemical fume hood. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended. Wearing two pairs of nitrile gloves is recommended. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Flame resistant laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** Hydrogen gas should never be used outside of a contained unit (i.e., glove box, chemical fume hood, or gas cabinet); therefore respiratory protection should not be required.

## Section 4 – Special Handling and Storage Requirements

Safety can be achieved while handling hydrogen gas by adhering to the below mentioned protocols, *but not limited to the following*;

- If compressed gas cylinder holding metal rack is used to restrain the cylinders, the rack must be bolted to the floor and the chains or rods must be at 1/3<sup>rd</sup> from the bottom and 1/3<sup>rd</sup> from the top of the cylinders. Clam shell (a cylindrical metal casing bolted to the floor) can be used to secure cylinders that need to be stored and used next to the experimental set-up.
- Always use Stainless Steel (SS) tubing to convey hydrogen gas. Teflon tubing is okay *if* specified by the manufacturer.
- Remove the regulator and place the safety cap on, when the cylinder is not in constant use.
- Hydrogen gas leak detector installation is recommended.
- Prevent hydrogen leaks by meticulously connecting gas regulator and tubing.
- Keep constant vigilance to immediately detect accidental leaks.
- Prevent accumulations of leaked hydrogen using plentiful ventilation.
- Eliminate likely ignition sources, and suspect unknown ignition sources.
- Store hydrogen gas cylinders away from electrical panels and emergency eyewash & safety shower.
- Always assume hydrogen is present, and verify the system has been purged to less than 1 percent when performing system maintenance on a hydrogen system. Inert gases such as Nitrogen & Argon can be used for purging.
- Always assume oxygen is present, and verify the system has been purged to the appropriate level when reintroducing hydrogen into a system.
- Have a lab buddy system in place when working with highly flammable gases such as Hydrogen
- All users must have had hands-on training to work with highly flammable gases. The training must be documented.
- Lab personnel handling highly flammable gases must have easy access to an Emergency Eyewash & Safety Shower within 10 seconds (i.e., travel distance no greater than 100 feet).

## Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**.

## Section 6 – Waste Disposal Procedures

Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended) away from incompatible chemicals such as aqueous solutions. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

## Section 7 – Protocol (Add lab specific Protocol here)

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from Principal Investigator.

## Section 8 – Documentation of Training (signature of all users is required)

Prior to conducting any work with hydrogen gas, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Hydrogen Peroxide

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Hydrogen peroxide is a strong oxidizer that has a potential to cause a fire or explosion in contact with incompatible materials such as combustibles (e.g., wood, paper, organic solvents). It is corrosive and light-sensitive. It is toxic if swallowed and corrosive to the eyes and skin. Prolonged exposure may cause dermatitis.



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of hydrogen peroxide should be conducted in a properly functioning chemical fume hood whenever possible. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. Wearing two pairs of nitrile gloves is recommended. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

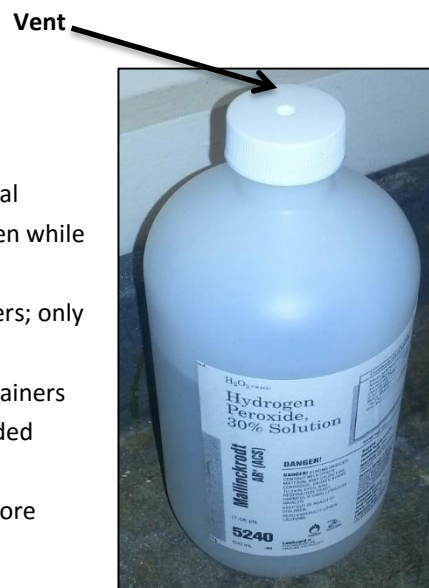
**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If hydrogen peroxide solution is being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (49-46371) so a respiratory protection analysis can be performed.

#### Section 4 – Special Handling and Storage Requirements

- Avoid contact with skin, eyes, and clothing. Avoid inhalation or ingestion.
- Hydrogen peroxide solutions greater than 10% should be kept in their original container with the manufacturer cap that allows the container to vent oxygen while in storage as shown in the picture to the right.
- Do not store hydrogen peroxide solutions greater than 10% in glass containers; only plastic containers should be used for storage.
- Keep container tightly closed in a dry and well-ventilated area. Opened containers must be carefully resealed and kept upright to prevent leakage. Recommended storage temperature is 2 – 8 °C.
- Store away from combustible materials. Do not store on wooden shelves. Store away from all organic compounds, including organic solvents.
- Avoid contact with powdered metals, zinc, iron, copper, nickel, and brass.



#### Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

#### Section 6 – Waste Disposal Procedures

Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended). No oxidizers are permitted to be poured down the drain. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

**Section 7 – Protocol/Procedure (Additional lab protocol may be added here)**

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from Principal Investigator.

**Section 8 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with hydrogen peroxide, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
|---------------------------|-----------|-----------------------------|
| Click here to enter text. |           | Click here to enter a date. |
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# Standard Operating Procedure

## Liquid Nitrogen

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 –Hazards

Liquid nitrogen is a cryogenic liquid that may cause severe frostbite or eye damage upon contact. It is an extremely cold liquid and gas under pressure and expands by a factor of 700 upon vaporization. Liquid nitrogen can cause rapid suffocation due to displacement of oxygen. Substances may become brittle upon contact and shatter. It may cause an explosion of a sealed container. Symptoms to exposure included frostbite, dizziness, salivation, nausea, vomiting, or loss of mobility and/or consciousness.



### Section 3 – Personal Protective Equipment (PPE)

For quantities less than 100 mL, safety glasses, lab gloves, long pants, and close-toe shoes are adequate (Figure 1). For intermediate quantities (100 mL – 1 L), also use splash goggles, face shield, and cryogenic gloves (Figure 2). For quantities greater than 1 L or filling a secondary Dewar, a cryogenic apron should be used in addition to the general use intermediate requirements (Figure 3).





**Figure 1 – Small quantity PPE requirements**



**Figure 2 – Intermediate quantity PPE requirements**



**Figure 3 – Large quantity PPE requirements**

## Section 4 – Engineering Controls

Liquid nitrogen must only be used in a well-ventilated area or in a properly functioning chemical fume hood whenever possible. Liquid nitrogen should never be used in a poorly ventilated enclosed area where oxygen displacement is a possibility.

## Section 5 – Liquid Nitrogen Containers

### Vacuum Insulated Containers:

Vacuum insulated containers are used for storing and dispensing liquid nitrogen. They are either sealed (capable of holding 20 psig – 240 psig with pressure relief valve) or ambient pressure (covered loosely with a cap, cork, or stopper and are referred to as Dewars (due'-werz)). There are two primary types of Dewars, benchtop and large Dewars. Benchtop Dewars (Figure 4) are typically for small-scale laboratory use and the lid is the only pressure-relief device. Large Dewars (Figure 5) are typically used for storage of lab samples, movement of samples between campus locations, or to fill other secondary containers. Large Dewars may have a secure seal and pressure relief vent. Liquid nitrogen exposure is a risk when handling Dewars. Therefore, the PPE illustrated in Figure 2 should be worn when working with a Dewar.



Figure 4 – Benchtop Dewar



Figure 5 – Large Dewar

### **Cryogenic Tubes:**

Cryogenic tubes are typically used for storage samples, movement of samples between campus locations, or for shipments off campus for collaborative research (Figure 6). There is no pressure-relief device on a cryogenic tube other than the lid. Consequently, cryogenic tubes can explode without warning. Explosions are likely caused by trapped nitrogen expanding inside of the tube during the thawing process. As the temperature increases, the tube may become over-pressurized and explode and may result in serious injuries. Because of this risk, the PPE illustrated in Figure 2 should be worn when directly handling a sealed cryogenic tube.



Figure 6 – Cryo Tubes

### **Self-Pressurizing Tanks**

Self-pressurizing tanks (Figure 7) are generally a 140 – 260 L double wall, stainless steel tank used to fill other liquid nitrogen containers such as Dewars. These tanks are equipped with pressure relief valves and a backup rupture disk. A loud hissing sound is commonly heard when the pressure relief valve opens. Exposure to liquid nitrogen can occur when connecting and disconnecting equipment, during the filling process, from a leaking valve, or from condensate ice buildup on valves and hoses. Because of these risks, the PPE illustrated in Figure 3 should always be worn when working with a self-pressurized tank.



Figure 7 – Self-Pressurizing Tank

## **Section 6 – General Safe Handling Practices and Storage Requirements**

- Only trained personnel should work with liquid nitrogen.
- Use only in well ventilated and low traffic areas.
- Caution signs should be posted in the area warning others that liquid nitrogen is being stored and used.
- Always wear the appropriate PPE.
- Liquid nitrogen should only be stored in approved containers.
- All liquid nitrogen containers must be labeled. Large containers (e.g., Dewars, Self-Pressurizing Tanks) must be labeled with the REM-provided label illustrated in Figure 8. Smaller containers such as cryogenic tubes should be labeled “Liquid Nitrogen, Cryogenic Hazard” or with similar words that convey the hazards.
- Avoid breathing liquid nitrogen vapors.
- Carry containers away from body and face.

- Never drop a liquid nitrogen container. Damage to a container may result in over-pressurization or container failure.
- Dewars more than 100 pounds require two people to move safely.
- Always use a specially designed cylinder cart to transport liquid nitrogen containers that are too heavy to be hand carried.
- Use the freight elevator whenever possible.
- Do not leave open containers unattended.
- Liquid nitrogen containers should be stored in cool, dry, and well ventilated areas.
- Do not store in a cold room or other controlled environment without air supply.
- Liquid nitrogen containers should be stored out of direct sunlight.



| LIQUID NITROGEN   |  | PURDUE UNIVERSITY  |  |
|---|--|--|--|
| Bldg./Room: _____   |  |    | <b>Warning:</b> Contains refrigerated gas; may cause cryogenic burns or injury   |
| Tare Weight: _____  |  |  |  |
| Fill Weight: _____  |  |  |  |
| <small>Check specific Dewar manufacturing specifications for tare and fill weight. Contact REM for assistance (49-40121).</small> |  | <b>Handling Procedures:</b> <ul style="list-style-type: none"> <li>• Only use containers approved for LN<sub>2</sub>.</li> <li>• Use in well ventilated area.</li> <li>• Transfer liquids slowly to prevent splashing.</li> <li>• <b>Never</b> restrict pressure relief device.</li> </ul> | <b>PPE Requirements:</b> <ul style="list-style-type: none"> <li>• Cryogenic gloves</li> <li>• Goggles and face shield</li> <li>• Long sleeves or lab coat</li> <li>• Long pants</li> <li>• Fully closed-toe shoes</li> </ul> |

Figure 8 – Liquid Nitrogen Label

## Section 7 – Spill and Accident Procedures

- Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**.

## Section 8 – Waste Disposal Procedures

- Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended) away from incompatible chemicals such as aqueous solutions. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/epps/rem/hmm/chemwaste.htm>.

## Section 9 – Protocol (Add lab specific Protocol here)

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from Principal Investigator.

## Section 10 – Documentation of Training (signature of all users is required)

Prior to conducting any work with nitrogen gas, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
|---------------------------|-----------|-----------------------------|
| Click here to enter text. |           | Click here to enter a date. |
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# Standard Operating Procedure

## Nitric Acid

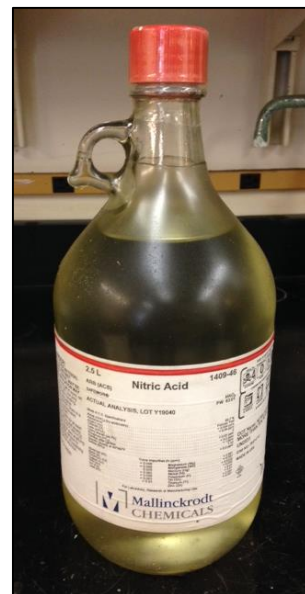
**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Nitric acid is an oxidizer that may intensify fires. Fire conditions may cause the formation of hazardous nitrogen oxides. It can react violently with organic chemicals such as organic solvents. Nitric acid may be harmful if inhaled, ingested, or absorbed through the skin. It is extremely destructive to the tissue of the mucous membranes and upper respiratory tract. It causes severe skin and eye burns and may cause blindness and permanent eye damage. Inhalation may cause spasms, inflammation and edema of the bronchi or larynx. Other symptoms include burning sensation, coughing, wheezing, shortness of breath, headache, nausea, vomiting, and pulmonary edema. Effects may be delayed. Large doses may conversion of hemoglobin to methemoglobin, producing cyanosis or a drastic fall in blood pressure, leading to collapse, coma, and possibly death. Chronic exposure may cause erosion of the teeth, jaw necrosis, and kidney damage.



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of corrosive materials should be conducted in a properly functioning chemical fume hood whenever possible. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Two-sets of chemical-resistant gloves (e.g., nitrile) should be worn (“double-gloving”). A heavy-duty glove, such as butyl rubber, Viton, or equivalent, is recommended, especially when handling concentrated nitric acid or more than 1L.

**NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.



**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield is also recommended

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If nitric oxide is being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (4-6371) so a respiratory protection analysis can be performed.

#### Section 4 – Special Handling and Storage Requirements

- Avoid contact with skin, eyes, and clothing.
- Keep container tightly closed in a dry and well-ventilated area. If possible, store in corrosive/acid/lab storage cabinet within a secondary containment (Nalgene/ polypropylene tray or tub). Store in original container away from direct sunlight.
- Avoid contact with alkali metals, reducing agents, cyanides, aldehydes, powdered metals, ammonia, and acetic anhydride, and all organic materials including organic solvents.
- Do not store in the top most shelf of the storage cabinet. In general, do not store chemicals at or above eye level.
- Ensure the container is tightly closed at all times.

#### Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

#### Section 6 – Waste Disposal Procedures

Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended). Nitric acid waste should be segregated from all incompatible chemicals such as caustics. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/epps/rem/hmm/chemwaste.htm>.

**Section 7 – Protocol (Add lab specific Protocol/Procedure here)**

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from PI.

**Section 8 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with nitric acid, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Oxidizers

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Important Definitions

- **Oxidizing liquid-** a liquid which, while by itself, is not necessarily combustible, may generally by yielding oxygen, cause or contribute to the combustion of other material. Hydrogen peroxide, nitric acid, and nitrate solutions are examples of oxidizing liquids commonly found in a laboratory.
- **Oxidizing solid-** a solid which, while by itself, is not necessarily combustible, may generally by yielding oxygen, cause or contribute to the combustion of other material.

### Section 3 – Hazards

Oxidizer should be kept away from heat, clothing, and other combustible materials. Take any precaution to avoid mixing with combustibles and store away from combustibles. Oxidizers can have other associated hazards, such as corrosive or toxic (e.g., nitric acid, sodium nitrite). Make sure that all of the potential hazards are understood before handling any chemical.

Common oxidizers include hydrogen peroxide, nitric acid, nitrate and nitrite compounds, perchloric acid and perchlorate compounds, and Hypochlorite compounds, such as household bleach. Oxidizers have a wide variety of applications including cleaners and disinfectants, agricultural fertilizers, rocket propellant and fuel, and explosives.





### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of oxidizing liquids and solids should be conducted in a properly functioning chemical fume hood whenever possible. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If oxidizers are being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (4-6371) so a respiratory protection analysis can be performed.

### Section 4 – Special Handling and Storage Requirements

- Do not over purchase; only purchase what can be safely stored in the laboratory.
- Avoid contact with skin, eyes, and inhalation. Avoid inhalation of vapor or mist. Avoid formation of dust.
- Keep away from combustible materials. Keep away from sources of ignition - No smoking.
- Keep containers tightly closed. Store in a cool, dry, and well-ventilated area away from incompatible substances such as flammable and combustible liquids.
- Keep cool and protected from sunlight.
- Opened containers of oxidizing liquids must be carefully resealed and kept upright to prevent leakage.
- Carefully follow manufacturer's instructions if oxidizing liquid needs to be vented during storage.
- Avoid using ignition sources (flame burners or any open flame source, hot plates, electrical equipment with frayed or cracked wiring, etc.) and/or creating static electricity in areas where oxidizing chemicals are being used.

## Section 5 – Spill and Accident Procedures

### Chemical Spill Dial 911

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and dial 911. If personnel have become exposed and need medical assistance, dial 911. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

## Section 6 – Waste Disposal Procedures

When possible, do not mix oxidizer waste streams with flammable or combustible waste. Store hazardous waste in closed containers that are properly labeled, and in a designated area away from incompatible chemicals. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

## Section 7 – Protocol (Additional lab protocol may be added here)

Click here to enter text.

**Section 8 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with oxidizers, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Perchloric Acid

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol is added to the protocol section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Perchloric acid is extremely corrosive. It is harmful if inhaled, ingested, or absorbed through the skin. Inhalation may cause irritation to the respiratory tract with burning pain in the nose and throat, coughing, wheezing, shortness of breath and pulmonary edema. Contact with skin causes burns and irritation. Eye contact causes burns, irritation, a may cause blindness. Ingestion may cause permanent damage to the digestive tract. Perchloric acid is destructive to the tissue of the mucous membranes and upper respiratory tract.

At concentrations >72%, perchloric acid is a strong oxidizer. Although not flammable itself, concentrated perchloric acid may ignite other combustible material and increase the intensity of a fire. Anhydrous (dehydrated) perchloric acid, or solutions with concentrations >85%, present a serious explosion hazard. At these concentrations, perchloric acid is unstable and can decompose explosively or spontaneously combust at ordinary temperatures if mixed with organic compounds.



### Section 3 – Engineering and Personal Protective Equipment (PPE)

**Engineering Controls:** The use of perchloric acid at concentrations <72% and at normal temperatures should be conducted in a properly functioning chemical fume hood. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute. Perchloric acid digestions or other procedures performed above room temperature should be conducted within a dedicated perchloric acid fume hood. Perchloric acid fume hoods are equipped with stainless steel ductwork and an exhaust wash-down system.

**Solvents must never be used or stored in a dedicated perchloric acid fume hood.**

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling perchloric acid.

**Hand Protection:** Two-sets of chemical-resistant gloves (e.g., nitrile) should be worn (“double-gloving”). A heavy-duty glove, such as butyl rubber, Viton, or equivalent, is recommended. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI-approved properly fitting safety glasses or chemical splash goggles are required. A face shield must also be worn.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. A chemical-resistant apron is also required. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** Perchloric acid should never be used outside of a chemical fume hood; however, if perchloric acid must be used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (49-46371) so a respiratory protection analysis can be performed.

## Section 4 – Special Handling and Storage Requirements

- Do not over purchase; only a minimum amount of perchloric acid should be stored in the laboratory.
- Avoid contact with skin and eyes. Avoid inhalation of vapor or mist. **Avoid formation of dust (explosion hazard!).**
- Always use inside a properly functioning chemical fume hood.
- **Note:** In case you need to dilute the concentration of perchloric acid, always add acid to water.
- Keep container upright and tightly closed in a dry and well-ventilated place.
- Containers which are opened must be carefully resealed and kept upright to prevent leakage. Date all opened perchloric acid containers.
- Keep away from sources of ignition. Avoid heat and shock or friction when handling.
- Store in original container and inside proper secondary containment made of glass or porcelain. Perchloric acid should not be stored in metal or plastic containers.
- Keep away from incompatible materials: acetic acid, acetic anhydride, alcohols, aniline, bismuth, combustible material, dehydrating agents, hydrochloric acid, organic chemicals, and oxidizers. As such, perchloric acid should be stored away from these chemicals, as well as wood or paper, within a steel cabinet, if possible.
- Use in the smallest practical quantities for the experiment being performed.
- Containers should be inspected monthly for discoloration. Submit a REM Chemical Waste Pickup Request for any discolored perchloric acid.
- Open bottles of perchloric acid should be used within one year. Old bottles should be submitted for Chemical Waste Pickup.

- A current copy of the SDS for perchloric acid must be made available to all personnel working in the laboratory at all times.
- Containers should remain closed when not in use.
- Transport all corrosives in secondary containment, such as glass or porcelain.

## Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. Do not attempt to soak up the spill using organic materials, such as Kimwipes or paper toweling, as **they may cause the perchloric acid to spontaneously ignite**. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121 during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

## Section 6 – Waste Disposal Procedures

Store waste perchloric acid in closed containers that are properly labeled, and in a designated area. Perchloric acid waste should be segregated from all incompatibles. No perchloric acid wastes are permitted to be poured down the drain. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

## Section 7 – Protocol **(Additional lab protocol may be added here)**

Click here to enter text.

**NOTE:** Any deviation from this SOP requires approval from Principal Investigator.

**Section 8 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with perchloric acid, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
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# Standard Operating Procedure

## Pyrophoric Materials

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol is added to the protocol section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Pyrophoric materials are classified as pyrophoric; and typically also classified as flammable liquids/solids, water reactive, and corrosives. Many are often toxic. They react violently with water liberating extremely flammable gas and are spontaneously flammable in air and causes burns. They pose a danger of serious damage to health by prolonged exposure through inhalation. Extreme caution is advised. Keep away from heat and sources of ignition. While it is often possible to work with these compounds using cannula transfer, traces of these compounds at the tip of the needle or cannula may catch fire and clog the cannula with lithium salts. Some workers prefer to enclose the needle tip or cannula in a short glass tube which is flushed with an inert gas and sealed via two septa. Examples include tert-butyllithium and triethylaluminum.



### Section 3 – Personal Protective Equipment (PPE) and Engineering Controls

**Engineering Controls:** Use of pyrophoric material must be conducted in an inert atmosphere; use of a glove box is recommended. Chemical fume hoods must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.



**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended. Wearing two pairs of nitrile gloves is recommended. **NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Flame resistant laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** Pyrophoric material should never be used outside of a chemical fume hood or glove box; therefore respiratory protection should not be required.

## Section 4 – Special Handling and Storage Requirements

- Precautions for safe handling: **Pyrophoric**, use extreme care when handling.
- Only handle under inert gas; use a glove box if possible. Do not expose to air.
- Avoid contact with skin and eyes and inhalation.
- A “dry-run” of the experiment should be performed using low-hazard materials such as water or an organic solvent.
- Never work with pyrophoric materials alone.
- Conduct the procedure only after a supervisor has observed the user performing the proper technique unassisted.
- A current copy of the SDS for the specific pyrophoric compound being used must be made available to all lab personnel at all times.
- All glassware used for pyrophoric materials should be oven-dried and free of moisture.
- Keep away from sources of ignition. Avoid heat and shock or friction when handling.
- Secure all pyrophoric material containers to a stand.
- Keep containers tightly closed. Store in a cool, dry and well-ventilated area away from incompatible substances.
- The amount of pyrophoric materials stored should be kept at a minimum.
- Any expired or unnecessary reactive materials should be properly disposed of as hazardous waste.
- All pyrophoric materials should be clearly labeled with the original manufacturer’s label, which should have the chemical name, hazard labels, and pictograms. The label should not be defaced in any way.
- All pyrophoric material should be placed into secondary containment as a precautionary measure.
- Suitable storage locations include inert gas-filled desiccators or glove boxes, flammable storage cabinets that do not contain aqueous or other incompatible chemicals, or intrinsically safe refrigerators or freezers that also do not contain aqueous or other incompatible chemicals.
- If pyrophoric materials are received in a specially designed shipping, storage, or dispensing container (such as the Aldrich Sure-Seal packaging system), ensure that the integrity of that container is maintained. Ensure that



sufficient protective solvent, oil, kerosene, or inert gas remains in the container while pyrophoric materials are stored.

### Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**.

### Section 6 – Waste Disposal Procedures

Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended) away from incompatible chemicals such as aqueous solutions. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

### Section 7 – Protocol (Add lab specific Protocol here)

Click here to enter text.

### Section 8 – Documentation of Training (signature of all users is required)

Prior to conducting any work with pyrophoric material, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
|---------------------------|-----------|-----------------------------|
| Click here to enter text. |           | Click here to enter a date. |
| Click here to enter text. |           | Click here to enter a date. |
| Click here to enter text. |           | Click here to enter a date. |
| Click here to enter text. |           | Click here to enter a date. |
| Click here to enter text. |           | Click here to enter a date. |

# Standard Operating Procedure

## Sulfuric acid, concentrated

**This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the PI and relevant lab personnel.**

### Section 1 – Lab-Specific Information

|  |   |
|--|---|
| <b>Building/Room(s) covered by this SOP:</b> | DRUG 210,210A, 201B, 274, 274B            |
| <b>Department:</b>                           | Chemistry                                 |
| <b>Principal Investigator Name:</b>          | Gaurav Chopra                             |
| <b>Principal Investigator Signature:</b>     | <a href="#">Click here to enter text.</a> |

### Section 2 – Hazards

Sulfuric acid is a highly corrosive mineral acid. The historical name of this acid is oil of vitriol. Sulfuric acid is harmful if inhaled, ingested, or absorbed through the skin. Inhalation may cause irritation to the respiratory tract with burning pain in the nose and throat, coughing, wheezing, shortness of breath, and pulmonary edema. Contact with skin causes burns and irritation. Eye contact causes burns, irritation, and may cause blindness. Ingestion may cause permanent damage to the digestive tract. It is destructive to the tissue of the mucous membranes and upper respiratory tract.



### Section 3 – Engineering Controls and Personal Protective Equipment (PPE)

**Engineering Controls:** Use of sulfuric acid should be conducted in a properly functioning chemical fume hood whenever possible. Avoid inhalation of vapor or mist. The chemical fume hood must be approved and certified by REM and have a face velocity between 80 – 125 feet per minute.

**Hygiene Measures:** Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Hand Protection:** Chemical-resistant gloves must be worn, nitrile gloves are recommended for low volume applications. Viton gloves are recommended for full contact exposure. **NOTE:** Consult with your preferred

glove manufacturer to ensure that the gloves you plan on using are compatible with the specific chemical being used.

**Eye Protection:** ANSI approved properly fitting safety glasses or chemical splash goggles are required. A face shield may also be appropriate depending on the specific application.

**Skin and Body Protection:** Laboratory coats must be worn and be appropriately sized for the individual and buttoned to their full length. Personnel must also wear full length pants, or equivalent, and close-toed shoes. Full length pants and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle must not be exposed.

**Respiratory Protection:** If sulfuric acid is being used outside of a chemical fume hood, respiratory protection may be required. If this activity is necessary, contact REM (4-6371) so a respiratory protection analysis can be performed.

## Section 4 – Special Handling and Storage Requirements

- Do not over purchase; only purchase what can be safely stored in the laboratory.
- Avoid contact with skin and eyes. Avoid inhalation of vapor or mist.
- Always use inside a chemical fume hood.
- Do not allow water to get into the container because of violent reaction.
- Note: In case you need to dilute the concentration of Sulfuric acid, always add the acid to water.
- Do not use with metal spatula or other metal items.
- Use in the smallest practical quantities for the experiment being performed.
- Keep container upright & tightly closed in a dry and well-ventilated place.
- Containers which are opened must be carefully resealed and kept upright to prevent leakage.
- Store in original container. Do not store Sulfuric acid in metal containers.
- Sulfuric acid must be segregated from incompatible materials. Sulfuric acid is incompatible with metals, oxidizing agents, reducing agents, bases, Acrylonitrile, azides, cyanides, chlorates, finely powdered metals, nitrates, perchlorates, permanganates, epichlorohydrin, aniline, carbides, fulminates, halides, picrates, organic materials, zinc salts, and flammable liquids.
- Containers should be labeled appropriately; the original manufacturer's label is acceptable. Label should indicate the name of the chemical(s) in the container. Avoid using chemical abbreviations (acceptable if a legend is present in the lab) and formulae.
- Transport all corrosives in secondary containment, such as polyethylene or other non-reactive acid/solvent bottle carrier.

## Section 5 – Spill and Accident Procedures

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and **dial 911**. If personnel have become exposed and need medical assistance, **dial 911**. If the spill is minor and does not pose a threat to personnel, contact REM at 49-40121

during normal business hours (Monday – Friday, 7 AM – 4 PM) for spill cleanup assistance (dial 911 if spill occurs after hours and assistance is needed).

**Section 6 – Waste Disposal Procedures**

When possible, do not mix acidic and basic waste streams. Store hazardous waste in closed containers that are properly labeled, and in a designated area (flammable cabinet is recommended) away from incompatible chemicals. Complete a Chemical Waste Pickup Request Form to arrange for disposal by REM; detailed instructions are provided at the following link: <http://www.purdue.edu/ehps/rem/hmm/chemwaste.htm>.

**Section 7 – Protocol (Additional lab protocol may be added here)**

Click here to enter text.

**Section 8 – Documentation of Training (signature of all users is required)**

Prior to conducting any work with sulfuric acid, the Principal Investigator must ensure that all laboratory personnel receive training on the content of this SOP.

**I have read and understand the content of this SOP:**

| Name                      | Signature | Date                        |
|---------------------------|-----------|-----------------------------|
| Click here to enter text. |           | Click here to enter a date. |
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| Click here to enter text. |           | Click here to enter a date. |

## **Tab 2:**

# **Lab-Specific Protocols, Requirements, Rules**

# Room Rules

## In this room: DRUG 210

Faculty or senior staff in charge: \_\_\_\_\_ 2/1/2016  
signature date

- A. eye protection: safety glasses or splash goggles  
at hood and at bench
  
- B. working alone with hazards:  
Never
  
- C. footwear required:  
Complete foot covered
  
- D. clothing required:  
Clothing covered to ankle and lab  
coat (flame proof if working with  
flammable chemicals) over the top  
layer of clothing. Gloves to be worn  
during all experimental procedures.
  
- E. eating in room allowed:  
NO

## Emergency Contact Information

Gaurav Chopra Lab

DRUG 2<sup>rd</sup> Floor

### A. Staff member associated with room:

|                     |
|---------------------|
| Name: Gaurav Chopra |
| Work phone:         |
| Emergency phone:    |

### B. Faculty member associated with work in room:

|                     |
|---------------------|
| Name: Gaurav Chopra |
| Work phone:         |
| Emergency phone:    |

### C. Safety Representative:

|                               |
|-------------------------------|
| Name: Jonathan Fine           |
| Work phone: 496-6617          |
| Emergency phone: 310-980-8682 |

### D. Other emergency contacts:

|                      |
|----------------------|
| Name: Ethan Hillman  |
| Work phone: 496-6617 |
| Emergency phone:     |

### E. Location of MSDSs:

|                            |
|----------------------------|
| Room: DRUG 210A            |
| Location: To Be Determined |
|                            |



**Tab 3:**

**Lab-Specific  
Hazard Assessments**

## Tab 3: Lab-Specific Hazard Assessments

### Chapter 1: CERTIFICATION OF PPE HAZARD ASSESSMENT

|                                   |                              |
|-----------------------------------|------------------------------|
| Supervisor (print): Gaurav Chopra | Assessment Date(s):          |
| Signature:                        | Location(s) posted: DRUG 210 |

| – <b>Hazards</b>      | <b>Task:</b> hands-on work or being within reach <sup>(a)</sup> of potential hazards of described activity/items: | <b>Minimum Requirements</b>   |
|-----------------------|---|---|
| Frostbite, eye impact | Dry ice, very cold frozen solids.   | Safety glasses, insulated gloves, skin cover to elbows/knees/throat, closed shoe w/ socks |

#### – *NOTES*

- (a) Being within reach of potential hazards: "within reach" varies widely depending on scale and conditions of work and will be judged by affected staff in each room.
- (b) Unshielded: not behind a drawn hood sash or blast shield.
- (c) Corrosive:  $\text{pH} \geq 12$  or  $\text{pH} \leq 2.5$
- (d) Toxic: having any poisonous or irritating effects to human tissue or human health.
- (e) Chemical resistant gloves: glove thickness, length, and material must be chosen carefully and will be specific to the chemicals/mixtures used and the process conditions.
- (f) Hood: 100% exhaust to outside, current approval for "all work" and functioning properly.
- (g) Chemicals requiring designated areas: full list is at <http://www.purdue.edu/rem/home/booklets/crdalist.pdf>

## Tab 3: Lab-Specific Hazard Assessments

### Chapter 1: CERTIFICATION OF PPE HAZARD ASSESSMENT

|                                   |                               |
|-----------------------------------|-------------------------------|
| Supervisor (print): Gaurav Chopra | Assessment Date(s):           |
| Signature:                        | Location(s) posted: DRUG 274A |

| – Hazards  | Task: hands-on work or being within reach <sup>(a)</sup> of potential hazards of described activity/items:  | Minimum Requirements  |
|--|---|---|
| Skin/eye damage, poisoning, inhalation of vapor or aerosol | Volume > 10 mL any unshielded <sup>(b)</sup> corrosive <sup>(c)</sup> liquids, organic liquids or liquid mixtures, or toxic <sup>(d)</sup> inorganic liquids/mixtures | Splash goggles, chemical resistant gloves <sup>(e)</sup> , lab coat, skin cover to knees/elbows/throat, closed shoes with socks. Work in hood <sup>(f)</sup> . Shower and eyewash must be available in work area. |
|  | Volume > 1 L  | Same, but cover to ankles/wrists/throat   |
|  | Volume > 5 L  | Add face shield covering chin   |
| Skin/eye damage  | Cryogenic liquids   | Splash goggles, skin cover to elbows/knees/throat, closed shoe easily removed, socks. Cryogloves for dispensing.  |
|  | Hot liquid (rxn mixture, water bath, oil bath, autoclave, still...)   | Splash goggles, insulated gloves, skin cover to knees/elbows/throat, closed shoe w/ socks   |
|  | Volume > 1 L  | Skin cover to throat/wrists/ankles, emergency shower available in work area   |
| Skin/eye damage, poisoning, inhalation of airborne dust    | Hazardous solids  | Safety glasses, goggles for large quantities, chemical resistant gloves, skin cover to elbows/knees/throat, closed shoes/socks  |
|  | > 100 g any hazardous solid, or > 1 g "chemical requiring designated area," (list at REM web site <sup>(g)</sup> ) or High potential for airborne particles           | Same, except skin cover to wrists/ankles, and only work in hood   |

#### – NOTES

- (a) Being within reach of potential hazards: "within reach" varies widely depending on scale and conditions of work and will be judged by affected staff in each room.
- (b) Unshielded: not behind a drawn hood sash or blast shield.
- (c) Corrosive:  $\text{pH} \geq 12$  or  $\text{pH} \leq 2.5$
- (d) Toxic: having any poisonous or irritating effects to human tissue or human health.
- (e) Chemical resistant gloves: glove thickness, length, and material must be chosen carefully and will be specific to the chemicals/mixtures used and the process conditions.
- (f) Hood: 100% exhaust to outside, current approval for "all work" and functioning properly.
- (g) Chemicals requiring designated areas: full list is at <http://www.purdue.edu/rem/home/booklets/crdalist.pdf>

## Tab 3: Lab-Specific Hazard Assessments

### Chapter 1: CERTIFICATION OF PPE HAZARD ASSESSMENT

|                                   |                               |
|-----------------------------------|-------------------------------|
| Supervisor (print): Gaurav Chopra | Assessment Date(s):           |
| Signature:                        | Location(s) posted: DRUG 210B |

| – <b>Hazards</b>      | <b>Task:</b> hands-on work or being within reach <sup>(a)</sup> of potential hazards of described activity/items: | <b>Minimum Requirements</b>  |
|-----------------------|---|--|
| Infectious disease    | Human blood, cells, tissue, body fluids or materials derived from same  | Safety glasses, "exam" gloves, skin cover on all potentially exposed areas, shoes/socks, work at Biosafety Level II. |
|                       | Liquid with vol > 1 mL  | Same, but splash goggles, skin cover to throat/wrists/ankles   |
| Frostbite, eye impact | Dry ice, very cold frozen solids.   | Safety glasses, insulated gloves, skin cover to elbows/knees/throat, closed shoe w/ socks                            |

#### – *NOTES*

- (a) Being within reach of potential hazards: "within reach" varies widely depending on scale and conditions of work and will be judged by affected staff in each room.
- (b) Unshielded: not behind a drawn hood sash or blast shield.
- (c) Corrosive:  $\text{pH} \geq 12$  or  $\text{pH} \leq 2.5$
- (d) Toxic: having any poisonous or irritating effects to human tissue or human health.
- (e) Chemical resistant gloves: glove thickness, length, and material must be chosen carefully and will be specific to the chemicals/mixtures used and the process conditions.
- (f) Hood: 100% exhaust to outside, current approval for "all work" and functioning properly.
- (g) Chemicals requiring designated areas: full list is at <http://www.purdue.edu/rem/home/booklets/crdalist.pdf>

## Tab 3: Lab-Specific Hazard Assessments

### Chapter 1: CERTIFICATION OF PPE HAZARD ASSESSMENT

|                                   |                              |
|-----------------------------------|------------------------------|
| Supervisor (print): Gaurav Chopra | Assessment Date(s):          |
| Signature:                        | Location(s) posted: DRUG 274 |

| – Hazards  | Task: hands-on work or being within reach <sup>(a)</sup> of potential hazards of described activity/items:  | Minimum Requirements  |
|--|---|---|
| Skin/eye damage, poisoning, inhalation of vapor or aerosol | Volume > 10 mL any unshielded <sup>(b)</sup> corrosive <sup>(c)</sup> liquids, organic liquids or liquid mixtures, or toxic <sup>(d)</sup> inorganic liquids/mixtures | Splash goggles, chemical resistant gloves <sup>(e)</sup> , lab coat, skin cover to knees/elbows/throat, closed shoes with socks. Work in hood <sup>(f)</sup> . Shower and eyewash must be available in work area. |
|  | Volume > 1 L  | Same, but cover to ankles/wrists/throat   |
|  | Volume > 5 L  | Add face shield covering chin   |
| Skin/eye damage  | Cryogenic liquids   | Splash goggles, skin cover to elbows/knees/throat, closed shoe easily removed, socks. Cryogloves for dispensing.  |
|  | Hot liquid (rxn mixture, water bath, oil bath, autoclave, still...)   | Splash goggles, insulated gloves, skin cover to knees/elbows/throat, closed shoe w/ socks   |
|  | Volume > 1 L  | Skin cover to throat/wrists/ankles, emergency shower available in work area   |
| Skin/eye damage, poisoning, inhalation of airborne dust    | Hazardous solids  | Safety glasses, goggles for large quantities, chemical resistant gloves, skin cover to elbows/knees/throat, closed shoes/socks  |
|  | > 100 g any hazardous solid, or > 1 g "chemical requiring designated area," (list at REM web site <sup>(g)</sup> ) or High potential for airborne particles           | Same, except skin cover to wrists/ankles, and only work in hood   |

#### – NOTES

- (a) Being within reach of potential hazards: "within reach" varies widely depending on scale and conditions of work and will be judged by affected staff in each room.
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- (d) Toxic: having any poisonous or irritating effects to human tissue or human health.
- (e) Chemical resistant gloves: glove thickness, length, and material must be chosen carefully and will be specific to the chemicals/mixtures used and the process conditions.
- (f) Hood: 100% exhaust to outside, current approval for "all work" and functioning properly.

## **Chapter 1: CERTIFICATION OF PPE HAZARD ASSESSMENT**

(g) Chemicals requiring designated areas: full list is at  
<http://www.purdue.edu/rem/home/booklets/crdalist.pdf>

## Tab 3: Lab-Specific Hazard Assessments

### Chapter 1: CERTIFICATION OF PPE HAZARD ASSESSMENT

|                                   |                               |
|-----------------------------------|-------------------------------|
| Supervisor (print): Gaurav Chopra | Assessment Date(s):           |
| Signature:                        | Location(s) posted: DRUG 274B |

| – Hazards  | Task: hands-on work or being within reach <sup>(a)</sup> of potential hazards of described activity/items:  | Minimum Requirements  |
|--|---|---|
| Skin/eye damage, poisoning, inhalation of vapor or aerosol | Volume > 10 mL any unshielded <sup>(b)</sup> corrosive <sup>(c)</sup> liquids, organic liquids or liquid mixtures, or toxic <sup>(d)</sup> inorganic liquids/mixtures | Splash goggles, chemical resistant gloves <sup>(e)</sup> , lab coat, skin cover to knees/elbows/throat, closed shoes with socks. Work in hood <sup>(f)</sup> . Shower and eyewash must be available in work area. |
|  | Volume > 1 L  | Same, but cover to ankles/wrists/throat   |
|  | Volume > 5 L  | Add face shield covering chin   |
| Skin/eye damage  | Cryogenic liquids   | Splash goggles, skin cover to elbows/knees/throat, closed shoe easily removed, socks. Cryogloves for dispensing.  |
|  | Hot liquid (rxn mixture, water bath, oil bath, autoclave, still...)   | Splash goggles, insulated gloves, skin cover to knees/elbows/throat, closed shoe w/ socks   |
|  | Volume > 1 L  | Skin cover to throat/wrists/ankles, emergency shower available in work area   |
| Skin/eye damage, poisoning, inhalation of airborne dust    | Hazardous solids  | Safety glasses, goggles for large quantities, chemical resistant gloves, skin cover to elbows/knees/throat, closed shoes/socks  |
|  | > 100 g any hazardous solid, or > 1 g "chemical requiring designated area," (list at REM web site <sup>(g)</sup> ) or High potential for airborne particles           | Same, except skin cover to wrists/ankles, and only work in hood   |
| Infectious disease   | Human blood, cells, tissue, body fluids or materials derived from same  | Safety glasses, "exam" gloves, skin cover on all potentially exposed areas, shoes/socks, work at Biosafety Level II.  |
|  | Liquid with vol > 1 mL  | Same, but splash goggles, skin cover to throat/wrists/ankles  |

#### – NOTES

- (a) Being within reach of potential hazards: "within reach" varies widely depending on scale and conditions of work and will be judged by affected staff in each room.
- (b) Unshielded: not behind a drawn hood sash or blast shield.
- (c) Corrosive: pH  $\geq$  12 or pH  $\leq$  2.5
- (d) Toxic: having any poisonous or irritating effects to human tissue or human health.

## Tab 3: Lab-Specific Hazard Assessments

### Chapter 1: CERTIFICATION OF PPE HAZARD ASSESSMENT

- (e) Chemical resistant gloves: glove thickness, length, and material must be chosen carefully and will be specific to the chemicals/mixtures used and the process conditions.
- (f) Hood: 100% exhaust to outside, current approval for "all work" and functioning properly.
- (g) Chemicals requiring designated areas: full list is at <http://www.purdue.edu/rem/home/booklets/crdalist.pdf>