Indiana University of Pennsylvania
OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY

Indiana University of Pennsylvania

College of Natural Science and Mathematics

College Laboratory Safety Plan

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ACRONYMS Used in this Manual

ACGIH American Conference of Governmental Industrial Hygienists
ANST American National Standards Institute
BSO Biological Safety Officer
CCR Chemical Cartridge Respirator
CFR Code of Federal Regulations
CHO Chemical Hygiene Officer
CHP Chemical Hygiene Plan
CLSP College Laboratory Safety Plan
CNSM College of Natural Sciences and Mathematics
CSC College Safety Committee
CSO Chemical Safety Officer
DC Department Chairperson
DCNSM Dean of the College of Natural Sciences and Mathematics
DOT Department of Transportation
DSC Department Safety Committee
EPA United States Environmental Protection Agency
IUPA International Union of Pure and Applied Chemists
LC Laboratory Coordinator
LC50 Lethal Concentration 50
LD50 Lethal Dose 50
NFPA National Fire Protection Association
NIOSH National Institute for Occupational Safety and Health
NTP National Toxicology Program
OSHA Occupational Safety and Health Administration
PEL Permitted Exposure Level
PI Principle Investigator (include supervisor for teaching assistants and laboratory preparers)
RSO Radiation Safety Officer
SDS Safety Data Sheet (Formerly Material Safety Data Sheet)
SOP Standard Operating Procedure
TLV Threshold Limit Values

Contact List

The listing below provides a complete listing of each person, their title, and their contact information. These persons will be referred to their title in the chemical hygiene plan.

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1.0 Introduction

1.1 Purpose

The College of Natural Sciences and Mathematics and Indiana University of Pennsylvania is committed to protecting faculty, staff, and students from health and physical hazards associated with chemicals in university laboratories. Every effort is made to ensure that risks, including those from hazardous chemicals, are mitigated to an acceptable level through appropriate engineering controls, specific procedures, and policies instituted by the college and university. While the college's and university's administration has provided significant resources to ensure that the vital research performed is done in full compliance with applicable federal, state, and local regulations, the responsibility for ensuring a safe workplace must truly be a shared responsibility between faculty, staff, students, and campus EH&S professionals.

The College Laboratory Safety Plan (CLSP) was developed to maintain compliance with the OSHA Laboratory Standard as well as follow guidelines outlined in *Prudent Practices*. In addition to OSHA regulations, this document also presents key information on the practices and procedures that must be implemented to maintain compliance with other key state, federal, and local regulations required for the use and storage of hazardous chemicals.

1.2 Background on Regulatory Compliance

The Occupation Safety and Health Act of 1970 established the Occupational Safety and Health Administration (OSHA). The mission of OSHA is to save lives, prevent injuries, and protect the health of America's workers. Beginning in the early 1970s, a variety of groups and individuals representing laboratories contended that the existing OSHA standards were designed to protect workers from exposure conditions in industry and were inappropriate for the different exposure conditions in research laboratories. To correct this situation, OSHA developed a special regulatory section specific for universities and non-production laboratories. This standard, *Occupational Exposure to Hazardous Chemicals in Laboratories,* is often referred to as the OSHA Laboratory Standard (29 CFR 1910.1450).

The requirements imposed by the OSHA Laboratory Standard include:

- Designating personnel to manage safety;
- Preparing and maintaining a written safety plan;
- Training and informing laboratory personnel of the hazards posed by the chemicals used in the teaching and/or research laboratory;
- Protecting laboratory personnel from physical and health hazards associated with hazardous chemicals in laboratories;
- Specific Engineering Controls;
- Specific storage requirements for hazardous materials;
- Limitations on the quantities of hazardous materials;

- Handling, storage, and disposal requirements for hazardous waste, and,
- Restrictions on the shipping and transporting of hazardous materials.
- Keeping chemical exposures below specified limits;
- Providing for medical consultations and exams, as necessary;

As defined by Pennsylvania's Worker and Community Right to Know Act (Act 159 of 1984), public sector workers (including state and local government agencies and public schools and public universities) and private sector employers not covered by the OSHA Hazard Communication Standard must post notices informing employees of their rights under the law. Safety training and education must be made available annually to all persons performing duties within the area specified. Upon request, all workers shall have access to an inventory of chemicals that are contained in their immediate surroundings. This listing must be kept up to date annually. MSDS must be made available for all chemicals listed in the inventory. All chemicals must be labeled as detailed herein.

The regulations promulgated under the General Safety Law cover a wide variety of employee safety issues for all places where persons are employed or permitted to work for compensation of any kind. The regulations promulgated under the General Safety Law are found in Title 34 of the Pennsylvania Code, Sections 6.1 through 47.398.

Other regulations that may be applicable to university laboratories are listed below. It should be mentioned that agencies often do not have their own regulation, yet readily adopt other agencies regulations.

- The Bloodborne Pathogens Standard (29 CFR 1910.1030)
  The Personal Protective Equipment Standard (29 CFR 1910.132)
  The Eye and Face Protection Standard (29 CFR 1910.133)
  The Respiratory Protection Standard (29 CFR 1910.134)
  The Hand Protection Standard (29 CFR 1910.138)
  The Control of Hazardous Energy Standard (29 CFR 1910.147)
  Air Contaminants Standard (29 CFR 1910.1000)
  Formaldehyde Standard (29 CFR 1910.1048)
  Select Biological Agents and Toxins (42 CFR 73.4 and 121.4)
  Ionizing radiation (29 CFR 1910.1096)
  Radio Active Isotopes (NRC and 10 CFR 31.11 and 35.12)
  Noise (29CFR 1910.95)

The OSHA Laboratory Standard (29 CFR 1910.1450 – Occupational Exposure to Hazardous Chemicals in Laboratories) applies to non-production, college teaching and research laboratories on campus that handle hazardous chemicals. The CNSM extends the OSHA Laboratory Standard to all university faculty, staff, and students. Ultimately, the Safety and Health of our students is the primary focus for this safety plan. The CNSM adopts Prudent Practices in the Laboratory, as outlined below and as official guidelines for laboratory safety, within the CNSM at Indiana University of Pennsylvania.

1.3 Scope and Applicability

This document, in and of itself, is not sufficient to maintain compliance with OSHA regulations. The complete Hygiene Plan for each laboratory consists of two elements:

1. The College Laboratory Safety Guide

This document outlines roles and responsibilities for key personnel, contains policies and practices applicable to the entire campus, and provides an understanding of the applicability of various regulations to operations in a campus laboratory. The Laboratory Safety Guide is prepared by the CNSM Safety Committee with guidance from the Biological, Chemical, and Radiation Safety Officers. This document contains a wealth of information on safety topics.

2. The Departmental Specific and Laboratory Specific Safety Plans

Each Department will prepare a Department Specific Laboratory Safety Plan and submit it to the CNSM Dean's office by March 1st of each year using the approved template. The Departmental Specific Laboratory Safety Plan covers departmental personnel, room locations and their safety features, departmental specific policies, and standard operating procedures (SOPs). Each department chairs has the responsibility for ensuring the completion of this safety plan; however, each chair is encouraged to use their departmental safety committee to make adjustments each year. Keeping an electronic copy of this plan for future editing is suggested.

The Laboratory Specific Safety Plan covers laboratory personnel, laboratory specific policies, standard operating procedures (SOPs), prior approvals, and an orientation checklist form. At their discretion, each PI has the option to use this template to create their own laboratory safety plan. PIs are advised to use these forms when training incoming laboratory members (*i.e.* the orientation checklist and the procedure form). Again, keeping an electronic copy of this plan for future editing is suggested.

A template for the Departmental and Laboratory Specific Safety Plans can be found on the CNSM R: drive.

1.4 Scope and Applicability

The College Laboratory Safety Plan describes the necessary protection from risks posed by the laboratory use of hazardous chemicals and is limited to laboratory settings (where small amounts of hazardous chemicals are used on a laboratory-scale on a non-production basis). All CNSM laboratories, whether teaching or research, must comply with the elements of this plan. While certain organizations within or associated with the university have the option of adopting their own Chemical Hygiene Plans, those plans must, at a minimum, meet the elements outlined within this document and the Departmental or Laboratory CHP template.

This plan does not specifically address protection needed against radiological, biological or other hazards (electrical, laser, mechanical, etc.), though elements of these may be covered in lab-specific SOPs that can be found in the Laboratory-Specific CHP.

1.5 Implementation of the Plan

The OSHA Laboratory Standard requires the designation of personnel responsible for implementation of the Chemical Hygiene Plan (CHP). The Colleges CHP is contained in the College Laboratory Safety Guide. The Laboratory Standard calls for the assignment of a Chemical Hygiene Officer (CHO) which will be Chemical Safety Officer (CSO). The NSM Dean will be responsible for the selection of the CNSM CSO. This individual has the responsibility for development and evolution of the CNSM Laboratory Safety Plan. Each department chair, with guidance from the College Safety Committee, will be responsible for the implementation of the departmental Laboratory Safety Plan in their department and for ensuring overall compliance with all chemical safety regulations. A departmental safety committee may be helpful for assistance with this charge, but ultimate responsibility will fall onto the department chair.

For laboratories in each department, the department chair designates the Principal Investigator(s) as the individual(s) responsible for developing and implementing the Laboratory Specific Safety Plan for laboratories under their control. The ultimate responsibility for the compliance of laboratory safety, including all safety regulations, will reside with the Principal Investigator.

1.6 Availability of the Plan

The CNSM Laboratory Safety Plan is readily available to all faculty, staff, and students at http://www.iup.edu/natsciandmath/default.aspx. Templates for the Departmental or Laboratory Specific Plans are located on the college R: drive.

1.7 Annual Review and Evaluation

The CNSM CSO shall review and evaluate the effectiveness of the CNSM CSP annually each Fall and update it as necessary. The CNSM Safety Committee will review and approve all changes to the plan. Updates to the CHP will be posted on the CNSM website (http://www.iup.edu/natsciandmath/default.aspx).

For a Departmental or Laboratory Specific Safety Plans to be useful it must reflect the work that is currently performed within the laboratory. The department chairs must formally review the Departmental Laboratory Safety Plan annually each Spring to ensure that its contents are appropriate and adequate for current operations. If changes are necessary before the review date, the Safety Plan must be amended and the changes approved by the respective department chair. Although PIs are not mandated to complete a Laboratory Safety Plan, they are fully encouraged to do so and update it annually.

2.0 Roles and Responsibilities

In order to maintain an effective safety program, it is important for all parties to clearly understand the responsibilities inherent in their roles. Below are assigned roles and responsibilities which are necessary to remain compliant with chemical safety regulations.

For the sake of this document, a Principal Investigator is any individual who has primary responsibility for the operations of assigned laboratory space. In most instances this will be an Indiana University of Pennsylvania faculty member. In some instances a facility director or department chair may assign the responsibilities outlined in this plan to a member of the academic staff (e.g., a supervisor of an instrumentation laboratory can be considered a Principal Investigator for the purposes of this plan).

Failure to comply with student safety training, laboratory inspections, or any part of the College Laboratory Safety Plan will result in disciplinary actions by the Dean of the College of Natural Science and Mathematics such as closure of research labs and/or stoppage of materials/equipment orders.

2.1 Director, Environment, Health & Safety (EH&S) Department

The Director of EH&S will provide the necessary staffing and resources for maintaining an effective Chemical Safety Program.

2.2 Environment, Health & Safety Department (EH&S) Staff

Environment, Health & Safety Department staff have extensive expertise covering all areas of safety and compliance. EH&S can work with student interns to complete their assigned tasks. EH&S personnel will:

- Provide access to MSDS to the university community through msds.com;
- Develop campus safety policies in conjunction with the appropriate campus faculty committees;
- Conduct inspections and certify chemical fume hood once a year;
- Conduct inspection on chemical eyewash and safety shower stations every semester;
- Perform fire extinguisher inspections yearly;
- Conduct air exchange studies of teaching, research, and prep laboratories every 5 years;
- Perform inspections of teaching, research, and prep laboratories each year; and
- Check chemical storage pattern sheets when conducting inspections.

2.3 CNSM Biological Hygiene Officer

The Natural Science and Mathematics Biological Safety Officer (BSO) has the primary responsibility for writing and updating the CNSM Laboratory Safety Plan with regard to biological safety. The BSO will:

- Assist the CSO and RSO in the review and updating of the CNSM LSP;
- Maintain and update additional guidance documents;
- Facilitate the CNSM community's understanding of, and compliance with, required biological health and safety regulations;
- Provide technical guidance to department chairs, department committees, and Principal Investigators on the development and implementation of Departmental Specific and Laboratory Specific LSPs;
- Provide guidance for the safe handling, storage, and disposal of used biological material for the CNSM community;

2.4 CNSM Chemical Safety Officer

The Natural Science and Mathematics Chemical Safety Officer (CSO) has the primary responsibility for editing and updating the College Laboratory Safety Plan. The CSO will:

- Have Hazmat Awareness and Operations training (Technician level training is optional) with yearly refresher training;
- Take the national certification test for Chemical Hygiene Officer offered by the National Registry of Certified Chemists and maintain certification requirements each year;
- Review and update the CNSM Laboratory Safety Plan;
- Maintain and update additional guidance documents;
- Facilitate the CNSM community's understanding of, and compliance with, required chemical health and safety regulations;
- Provide technical guidance to department chairs, department committees, and Principal Investigators on the development and implementation of Departmental Specific and Laboratory Specific LSPs;
- Coordinate campus chemical emergency response with campus police and the Indiana Fire Department's Hazardous Incident Response Team;
- With the assistance of the storeroom clerk, maintain a chemical inventory of materials located in the NSM stockroom (room 146) and the hazardous chemical storage facility (room 126A);
- Provide guidance for the safe handling, storage, and disposal of used chemicals for the CNSM community; and
- Facilitate waste minimization by redistributing surplus chemicals.

2.5 CNSM Radiation Safety Officer

The Natural Science and Mathematics Radiation Safety Officer (RSO) has the primary responsibility for writing, reviewing, and updating relevant sections of the CNSM Laboratory Safety Plan. The RSO will:

- Assist the BSO and CSO in the review and updating of the CNSM Laboratory Safety Plan;
- Maintain and update additional guidance documents;
- Facilitate the CNSM community's understanding of, and compliance with, required radiation health and safety regulations;
- Provide technical guidance to department chairs, department committees, and Principal Investigators on the development and implementation of Departmental Specific and Laboratory Specific Safety Plans;
- Provide guidance for the safe handling, storage, and disposal of used radioactive materials for the CNSM community;
- Fulfill regulatory responsibilities for licensed isotope;
- Facilitate efforts to implement processes that are environmentally friendly.

2.6 College Safety Committee

The CNSM Safety Committee is comprised of university faculty and staff may be drawn from organizations and departments from within the college. At a minimum the BSO, CSO, and RSO must be members. The College Safety Committee will:

- Annually review and approve the College Laboratory Safety Plan;
- Review Laboratory Inspection Forms, Departmental Specific Laboratory Safety Plans annually and ensure compliance;
- Assist the department chairs of the department with updating Departmental and Laboratory Specific Safety Plans;
- Ensure all college safety showers, eyewash stations, and fire extinguishers have been inspected each semester to ensure their proper operation.

2.7 Department Chair

The Chair of each department has the primary responsibility for the implementation and overall compliance with chemical safety regulations within their own academic department and for ensuring compliance with all elements of the College, Department Specific, and Laboratory Specific Safety Plans. The Chair of each department must:

- Review compliance with University and College policies and recommend methods to promote compliance;
- Ensure all laboratory Evacuation and Information sheets are updated annually each September or when changes occur;

- Ensure that each teaching and research laboratory maintains and updates a chemical inventory annually each spring;
- Ensure that each teaching and research laboratory maintains and updates a chemical storage pattern form;
- Ensure laboratory inspections occur each academic year in accordance to the College Laboratory Safety Plan; and
- Update the Departmental Specific Laboratory Safety Plan yearly as well as gather updates for Laboratory Specific Safety Plans.

2.9 Departmental Safety Committee

The Department Safety Committee is comprised of university faculty and staff may be drawn from within each department. The Department Safety Committees will:

- Assist the chair of the department with updating Departmental and/or Laboratory Specific Safety Plans;
- Review department laboratory safety policies annually;
- Assist department with safety training.

2.10 Principal Investigator (Student Supervisor)

The Principal Investigator has the primary responsibility for providing a safe work environment and for ensuring compliance with all elements of the College and Laboratory Safety Plans within their own assigned laboratory space. Any IUP personnel that has a supervisory role of students who work with materials mentioned herein are considered the students PI. This includes students who are teaching assistants and laboratory preparers. The Principal Investigator will:

- Approve necessary SOPs, ensuring that PPE, engineering controls, and administrative controls described within the SOPs provide adequate protection to laboratory personnel;
- Maintain compliance with federal, state, and local regulations related to the use of hazardous chemicals in their laboratory (as outlined in this document);
- Provide access to chemical inventories, MSDSs, safety plans, and other safety-related information for laboratory staff and students;
- Ensure that workers understand and follow the chemical safety policies, practices, and regulations related to their laboratory's operation;
- Ensure all students have taken appropriate college safety training and have filled out and signed the orientation checklist;
- Update laboratory personnel form and post in laboratory near entrance;
- Assess individual roles of their workers and hazards associated with those roles;
- Ensure that PPE and required safety equipment are available and in working order and that laboratory staff is trained in their use;
- Determine training needed for laboratory workers based on their duties and tasks and ensure appropriate training has been provided. While the College provides

some general instruction, training on laboratory-specific operations must be provided. This includes determining which of the three safety modules the student needs (biological, chemical, and radiation) as well as ensuring that the student has provided a copy of their certificate(s) as well as the Student Orientation Checklist prior to the student starting any laboratory work, to include preparing or teaching assistant work;

- The PI, or supervisor, will keep copies of the training certificates and orientation checklists;
- Ensure that laboratory personnel is knowledgeable on emergency plans, including fires, equipment failure, and chemical spills;
- Complete and keep the Laboratory Emergency Door Card up to date (New cards will be available every August and upon request). These are also available from your department secretary;
- Ensure any refrigerators used contain appropriate labels to include labeled shelf space and off hours contact numbers;
- Conduct regular chemical hygiene inspections and housekeeping inspections, including inspection of emergency equipment;
- Correct any unsafe conditions identified within the laboratory;
- Maintain documentation on training, approvals, and other safety related issues, as outlined in this document;
- Ensure proper disposal of hazardous materials according to university and college procedures;

2.11 Laboratory Personnel

The ultimate responsibility for safety rests with every person who works the laboratory. Laboratory personnel include students who are teaching assistants and laboratory preparers. Individuals working under the supervision of the Principal Investigator must:

- Follow campus and laboratory practices, policies, and SOPs and as outlined in the Campus and Laboratory CHPs;
- Attend all safety training as required by the College Safety Committee and the Principal Investigator;
- Filled out and signed the Orientation Checklist for your research laboratory;
- Provide the training certificate(s) for the required training and the Orientation Checklist prior to starting any lab work (including student workers or laboratory preparers);
- Perform only procedures and operate only equipment that they have been authorized to use and trained to use safely;
- Check relevant information on the chemical reactivity and physical and toxicological properties of hazardous materials (such as the Material Safety Data Sheet or the *Laboratory Safety Guide*) prior to use of the material;

- Have knowledge of emergency procedures prior to working with hazardous chemicals;
- Incorporate safety in the planning of all experiments and procedures;
- Use the personal protective equipment and hazard control devices provided for his/her job;
- Routinely check that engineering controls are functioning;
- Ensure that equipment is safe and functional by inspection and preventative maintenance, including glassware, electrical wiring, mechanical systems, tubing and fittings, and high energy sources;
- Keep work areas clean and orderly;
- Avoid behavior which could lead to injury;
- Dispose hazardous waste according to university procedures;
- Report incidents or near misses involving chemical spills, exposures, work-related injuries, and illnesses or unsafe conditions to Principal Investigator; and,
- Consult with the Principal Investigator or with any College Safety Officer on any safety concerns or questions.

3.0 General Laboratory Rules and Policies

The CNSM Safety Committee has the ability to develop, review, and approve college policies on issues related to the purchase, use, storage, and disposal of biological, chemical, or radiological material. All college personnel are subject to these policies in addition to federal state, and local regulations and codes.

Each Principal Investigator has the right to set polices for laboratories under their control as long as these are, at a minimum, compliant with regulations and college-wide policies. Laboratory specific policies, if any, shall be included in the Laboratory CHP.

The following general policies apply for all laboratory operations involving hazardous chemicals:

- *It is college policy* that appropriate PPE must be worn at all times. At a minimum, close-toed shoes and safety glasses must be worn whenever hazardous chemicals are present in the laboratory.
- *It is college policy* that ANSI Z87.1-2010 D3 approved goggles are to be worn when there is a chemical splash hazard of a hazardous chemical in all college labs.
- *It is college policy* that no eating and drinking is allowed in a room where biological, chemical, or radiological materials are present.
- *It is college policy* that gloves of any kind will be removed while in the hallway or when moving between labs to limit the spread of contamination whether it is chemical, biological, or radiological in nature.
- *It is college policy* that unnecessary exposure to biological, chemical, or radiological materials via any route will be avoided through proper use of engineering controls, personal protective equipment, and administrative controls.

- *It is college policy* that good housekeeping practices be upheld in all laboratories and that all passageways, exits, utility controls, and emergency equipment (*i.e.* safety shower and eyewash stations) remain accessible at all times.
- *It is college policy* that any procedure or operation identified by laboratory or EH&S staff as imminently dangerous (i.e., the operation puts individuals at immediate serious risk of death or serious physical harm) must be immediately stopped until corrective action is taken.

4.0 Hazardous Chemical Identification and Control

4.1 Risk Assessments

Some chemicals can cause immediate health problems as well as long-term health effects. Examples include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. Hazardous chemicals can also pose inherent physical dangers (such as flammable and combustible liquids, compressed gases, and unstable and water-reactive materials). The CNSM at Indiana University of Pennsylvania is committed to minimizing worker exposure to the hazards imparted by use of hazardous chemicals and takes a risk-based approach in determining means of mitigating risk taking into account the characteristics of the chemical, the amounts used, the method in which a chemical is used, and the location.

The university requires that each Principal Investigator review all operations involving laboratory use of hazardous chemicals and implement control measures commensurate with the risk. Control measures include personal protective equipment (gloves, eye protection, respirators, etc.), engineering controls (such as fume hoods, glove boxes, intrinsically safe hot plates, etc.), and administrative controls (such as policies against working alone or other additional laboratory policies).

4.2 Exposure Limits

It is the responsibility of the Principal Investigator to insure that laboratory staff and student members have knowledge of the exposure limits applicable to the chemicals that are used within the lab. OSHA has the regulatory authority to set specific air exposure limits for chemicals. These Permissible Exposure Limits (PELs) are listed in 29 CFR 1910.1000 TABLE Z-1.

For substances that do not have an exposure limit specified in the OSHA standards, Communication 32 states that it will accept the recommendations of the American Conference of Governmental Industrial Hygienists (ACGIH) for threshold limit values.

While the published PELs and TLVs are enforceable, they were not created with a university laboratory setting in mind. The published ACGIH exposure limits, like the PELs, are levels to which it is believed nearly all workers may be exposed during a 40-hour work week over a working lifetime without harmful effects. Most laboratory workers perform non-routine operations over a short time span. In these instances short-term exposure limits are often more appropriate. Many chemicals do not have any published exposure limits. It is the university's policy, therefore, that all prudent steps will be taken to reduce exposures beyond what is legally required or, when there is no legal requirement, to minimize exposure by reasonable actions.

4.3 Personal Protective Equipment (PPE)

Exposure to hazardous chemicals can normally be minimized, if not eliminated, through proper selection of PPE. Typical examples of PPE include safety goggles, safety glasses, lab coat, gloves, and respirators. The Principal Investigator has the primary responsibility to determine the appropriate PPE and ensure that the PPE is made available. Details are important. If respirators are required, specific types of respirators must be indicated. The same is true for gloves – chemical compatibility plays a major role in determining the type of glove (e.g., latex, nitrile, vinyl). Information can be found on Safety Data Sheets, which often provide information on the proper choice.

While close-toed shoes and safety glasses are the minimum PPE requirements for all laboratories containing hazardous chemicals, the PPE required for specific procedures and tasks should be reflected in the Departmental Laboratory Safety Guide or the Laboratory Specific Safety Plan which are the primary tools for informing laboratory workers of the necessary protective clothing.

4.4 Engineering Controls

As stated above, a primary goal of chemical safety efforts is to minimize the potential for exposures. The PPE requirements discussed above are common ways to minimize risk. Often a more direct way of reducing exposure can be accomplished by isolating the source or removing contaminants through various ventilation methods. Engineering controls should be implemented within the laboratory whenever practical to minimize exposure to hazardous chemicals.

By far the most commonly used engineering control used in laboratories is the chemical fume hood. Fume hoods are especially effective when handling gases, vapors, or powders. Laboratory workers rely heavily on these, often while performing the most hazardous tasks.

Due to the importance placed on fume hoods some key requirements are emphasized below:

Laboratory workers must understand how to properly use chemical fume hoods. Principal Investigators need to ensure that workers have received the proper training.

- Fume hood inspection, testing, and maintenance are performed annually by the IUP EH&S. After inspection, a certification sticker is affixed to each fume hood, which lists the most recent certification date. Fume hoods with a certification date greater than one year must be put out of service until recertification is complete.
- New fume hoods or those that recently underwent maintenance must be tested prior to any hazardous operations. If the fume hoods are not working properly in

the laboratory, chemicals in the hood should be secured and the work stopped. Contact the chemical safety officer if any issues with the fume hoods have been detected.

- If equipped, fume hood alarms should never be disarmed.

Other ventilation methods, including general room ventilation, point-source, and gas cabinets also provide protection to workers. Glove boxes, glove bags, pressure relieve valves, automatic shut-offs, and air monitors are also routinely used.

Due to the reliance placed on these engineering controls, laboratory personnel need to incorporate regular inspections and/or testing of the controls into their standard operating procedures to ensure proper operation. This may be as simple as testing that air is flowing or gauges are working. Some controls are more complicated and may require routine maintenance or calibration by outside vendors.

4.5 Particularly Hazardous Substances (PHSs)

Regulations require that provisions for additional employee protection be made for work with particularly hazardous substances (PHSs). These include carcinogens, reproductive toxins, and substances that have a high degree of acute toxicity. As part of the required risk assessment for any work involving hazardous materials, all PHSs must be identified by the Principal Investigator and appended in the Laboratory Specific Safety Plan. Use of any PHS requires:

- Establishment of a designated area;
- Use of appropriate containment devices such as fume hoods or glove boxes;
- Procedures for safe removal of contaminated waste; and
- Decontamination procedures.

4.6 Prior Approvals

The nature of the work performed in laboratories on campus varies widely. Principal Investigators are relied upon to perform (or at minimum review) a risk assessment of all activities involving hazardous substances. Certain procedures may be considered hazardous enough that these should only be performed with prior approval of the Principal Investigator. While typically these may involve work with PHS, other procedures, such as those involving pyrophoric, highly reactive or flammable compounds, may appropriately fall within this category. The CNSM allows the Principal Investigator to make the determination if a procedure needs prior approval. Additionally, within the Laboratory Specific Safety Plan a section has been devoted to documentation of approvals.

5.0 Hazard Information Dissemination

One of the key requirements in chemical safety regulations is the communication of the potential hazards to which a worker may be exposed. This section describes the College of Natural Science and Mathematics’ policies for meeting these requirements.

5.1 Chemical Hygiene Plans

OSHA's Laboratory Standard requires the development of a Chemical Hygiene Plan, which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace. This document, in addition to the Departmental- and Laboratory Specific Safety Guides meet many of the requirements. Additionally, the entire CHP (including the Campus CHP, the Laboratory CHP, and the *Laboratory Safety Guide*) must be readily available to laboratory workers and worker representatives. These documents will be placed on the College website and updated annually following review by the College Safety Committee.

5.2 Safety Data Sheets and Other Safety Information

A Safety Data Sheet (SDS) is prepared by manufacturers and summarizes the physical and chemical characteristics, health and safety information, handling, and emergency response recommendations related to their products. A SDS should be reviewed before beginning work with a chemical in order to determine proper use and safety precautions. OSHA regulations require that once a chemical is present in the laboratory the MSDS must be made available, either electronically or as a hardcopy. Personnel must have ready access for reference in the case of emergencies. The International Fire Code (IFC) which has been adopted by the Indiana Fire Department (IFD) also states that MSDSs shall be readily available on the premises.

SDSs alone may not provide sufficient information on the hazards of a chemical. Laboratory personnel should review other sources of information on the chemical, such as the chemical literature or references on safe handling of chemicals such as National Research Council's *Prudent Practices in the Laboratory*. These resources should be made available to laboratory staff.

5.3 Exposure Monitoring Results

In certain instances IUP EH&S or the Environmental Health Program at University Health Services may measure laboratory worker exposure to a chemical regulated by a standard. The Principal Investigator must, within 15 working days after the receipt of any monitoring results, notify the laboratory staff of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

5.4 Labeling Chemical Containers

All containers must be labeled as to their contents. Manufacturer labels on chemical containers shall not be removed or defaced. Chemicals received from outside vendors or from departmental stockrooms will have labels indicating the chemical identity and common name, if applicable, with other physical and chemical data. Toxicity warning signs or symbols should be prominently visible on the labels.

Frequently, small quantities of chemicals are dispensed from the original shipping container to a smaller container. Any container that may be used by more than one person or that will contain the chemical for more than one day, regardless of who uses the container, must be labeled. Label information **must** include:

- The chemical name;
- The primary hazard(s);
- The responsible person; and
- The date.

If such chemicals are dispensed into a secondary container for the sole, immediate use of the person dispensing the chemical, and will be consumed over the period of a single day, the container must still be labeled with the chemical name and user. Chemical mixtures or special chemicals are often prepared in the laboratory. Containers of these chemicals must be marked with the chemical name(s), primary hazard(s), person(s) responsible for the preparation, and date. It is acceptable to use one label for a rack containing individual vials of similar chemicals. No cork stoppers, round-bottomed flasks can be used, only vials or bottle with screw cap can contain materials.

Waste containers must be labeled as to the name of the department, the date, the originator, the lab or room number, the hazard class, all relevant contents, the estimated amount of each, container size, and pH if aqueous. Labeling as “solid waste” or “liquid waste” is not sufficient. Every waste container will be labeled with the following label (Form CNSM 2013-01):

Hazard Class (Circle one)	**USED CHEMICALS** CNSM 2013-01			
Organic	Department	Date	Originator	Lab/Room
Halogenated Org.	**Name of Used Chemical(s)**			**Estimated % Amount**
Reactive	Major ______________________________			______________
Oxidizers	Minor ______________________________			______________
Radioactive	Minor ______________________________			______________
Corrosive (Acid)	Minor ______________________________			______________
Corrosive (Base)	Minor ______________________________			______________
Toxic	Minor ______________________________			______________
Biomedical	Minor ______________________________			______________

Low Hazard	Container Size	**HANDLE WITH CARE**	Approx. pH of Contents __________

Once the waste bottle is full and properly labeled, it should safety be taken to the chemical store room and given directly to the Stockroom Manager in person. Waste is not to be left unattended.

5.5 Laboratory Emergency Door Cards

Hazard information dissemination is not only necessary for providing laboratory workers necessary information on the hazardous chemicals present, but also be provided to first responders in the event of an emergency. The Indiana Fire Department (IFD) as well as Indiana HazMat relies on the Laboratory Emergency Door Cards to provide valuable information and these cards are required by fire code. The College requires that the cards be, at a minimum, replaced in the event of any change in the information. It is suggested that these cards are replaced each year. Each academic department can find their door cards on the College Safety folder of the College Drive.

5.6 Refrigerator / Freezer and -80 Freezer Cards

Domestic, -80°C and Chemical refrigerators and freezer require documentation located on the door of the equipment. At a minimum this documentation should list emergency contact information in case of an extended power outage, leaks, or other emergency along with assigned shelves. Departments / PIs can use one of the College forms (CNSM 2013-05 version 1-version 3) or can make their own form as long as it contains the proper information.

No flammable chemicals or food/drinks are to be stored in domestic refrigerators as drain tubes may take flammable materials out of the refrigerator adjacent to the compressor. No food or drinks may be stored in laboratory refrigerators unless they are for personal use / food only. These refrigerators and or freezers should be labeled as “Food Only” via signage. No cardboard or other non-essential combustible items are to be used for primary or secondary containers. Chemicals, even those for temporary storage, will be placed in permanent primary containers; in no way will Parafilm, glass or cork stoppers and round-bottomed be used at any time. Carefully label items with non-water soluble ink. Small vials should be placed in non-combustible secondary containers.

Refrigerators and freezers should be checked for old and or expired materials no less than once a year.

5.7 College Ice Machines

Ice machines that produce ice for laboratories will not be used for human consumption. There will be no storage of food items in these ice machines. Signage will be posted (CNSM 2013-09) on ice machines used for laboratories. Personal ice machines can be used for human consumption and will need to be labeled as such.

6.0 Chemical Storage and Inventory

Use and storage of hazardous chemicals is regulated by federal, state, and local regulations. These regulations include OSHA and PA worker protection standards, emergency response and planning regulations and local building and fire codes. Each of these place limitations on how much materials can be used, where they can be used or stored, or require information on inventory to be available for emergency planning and response.

6.1 Chemical Storage and Use Limits

The College is subject to the International Fire Code (IFC), by virtue of its adoption by the Indiana Fire Department (IFD). IFD also enforces sections of the National Fire Protection Association (NFPA) standards since these have been adopted by IFC reference. Finally, OSHA 29 CFR 1910.106 "*Flammable and Combustible Liquid*s" is also enforceable. Together, these place limitations on use and storage of compressed gases, cryogenic fluids, highly toxic and toxic materials, flammable and combustible liquids, and water reactive solids, to name a few. The Indiana Fire Department may at any time inspect buildings and has the authority to cite any situation that they deem in violation of the relevant codes.

Every room in the College that stores hazardous materials (to include chemical, biological, and radiological) will need to fill out a storage pattern sheet that indicates the storage pattern for all hazardous materials.

The allowable quantities (both in use and in storage) per 2009 IFC are presented in tables found in **Appendix D**. Allowable quantities are based on control areas, defined as "spaces within a building which are enclosed and bounded by exterior walls, fire walls, fire separation assemblies and roofs, or a combination thereof, where quantities of hazardous materials not exceeding the exempt amounts are stored, dispensed, used or handled." Although the code limits appear straightforward, application of the code can be more complicated due to the following:

- While quantities are based on control areas, these may consist of more than one laboratory and the boundary of a control area is not obvious;
- Building features, such as the presence of sprinklers, can affect the allowable quantities;
- The quantities allowed are also dependent on the specific floor the laboratory is located. Generally, the higher the floor level the lower the allowable quantity per control area. Also the number of control areas tends to decrease; and,
- Changes to the fire codes are not always retroactively applied to existing structures.

Due to the complexities of the standards and the College's need to remain compliant with these regulations it is the College's policy that every effort be made to minimize the quantity of hazardous chemicals within laboratories.

In addition to the IFC limits, other limitations to storage and use apply. Below are some of the key policies and code requirements for storage of chemicals at Indiana University of Pennsylvania. This list is not comprehensive and does not include many of the prudent safety practices included in Laboratory Safety Guide.

Flammable Liquids:

In addition to the IFC code requirements, the following College limits have been set (in instances in which the building limits are more stringent, those limits will apply):

- No more than ten (10) gallons of flammable liquids per typical laboratory may be stored outside a flammable storage cabinet (with the exception of materials stored in approved safety cans). Exception can be made by the Chemical Safety Office for larger laboratory suites, though this cannot exceed fire code limits;
- Further limitations are placed on the quantities that can be placed in an individual container based on the type of container (glass, metal, etc.). See Table D2 in Appendix D; and
- Flammable liquids, if they need to be refrigerated, must be stored in laboratory-safe refrigerators. All the electrical components in this type of refrigerator are outside the refrigerator. UL-approved laboratory–safe refrigerators can be purchased. Refrigerators that are not laboratory-safe can be altered if modifications and signage in NFPA 45 *Standard on Fire Protection for Laboratories Using Chemicals* are used but modifications must be performed by a trained electrician. Contact the Chemical Safety Office for more information.

Gas Cylinders:

In order to ensure safe use and storage, gas cylinders must be:

- Stored within a well-ventilated area, away from damp areas, salts or corrosive atmospheres, and away from exit routes;
- Stored in an upright position with full cylinders separated from empty cylinders;
- Secured with a chain or appropriate belt above the midpoint but below the shoulder. Laboratory cylinders less than 18" tall may be secured by approved stands or wall brackets;
- Capped when not in use or attached to a system (if the cylinder will accept a cap);
- Kept at least 20 ft. away from all flammable, combustible or incompatible substances. Storage areas that have a noncombustible wall at least 5 ft. in height and with a fire resistance rating of at least 30 minutes may be used to segregate gases of different hazard classes in close proximity to each other; and,

Cryogenic Liquids:

- Storage areas for stationary or portable containers of cryogenic fluids in any quantity must be stored in areas with adequate mechanical ventilation or natural ventilation. If it can be demonstrated that there is no risk of oxygen depletion or harmful vapors then ventilation is not required upon EH&S approval.

- Indoor areas where cryogenic fluids in any quantity are dispensed must be ventilated in a manner that captures any vapor at the point of generation. If it can be demonstrated that there is no risk of oxygen depletion or harmful vapors then ventilation is not required upon EH&S approval.

6.2 Chemical Compatibility and Safe Storage

In addition to chemical storage limitations imposed by regulations and codes, the Principal Investigator is responsible for following prudent storage practices of chemicals. This includes separating incompatible chemicals and disposing of unstable compounds (such as peroxide formers) after their indicated expiration date. Chemicals must be grouped according to their hazard category (i.e. acids, bases, flammables, corrosives, etc.).

The College has a listing of hazard classes that it uses for the segregation of chemicals. The segregation is based off of the CRC Lab Handbook of 23 Groups and has been combined to group as many compatible groups as possible.

Storage Group	Storage Name	CRC Group Number
A	Organic Bases	4
B	Pyrophoric & Water Reactive	--
C	Inorganic Bases	3,19
D	Organic Acids, Phenols & Acid Anhydrides	2,15,23
E	Oxidizers including Peroxides, Epoixides, molec. Halogens	16,20
F	Inorganic Acids	1
G	Aromatic, Saturated, Unsat Hydrocarbons, Petroleum & Aldehydes, Esters, Nitriles	7,9,10,11,12,13,18
H	Cyanohydrins & Polmerizable esters, Monomers	14,17
I	Alcohols, Ethers, Ketones, Halogenated Hydrocarbons	5,6,8,21
J	Explosive or other highly Unstable Material	24
K	Non-Reactive/Non-Flammable Gas	25
L	Reactive or Flammable Gas	26
M	Biomedical	27
N	Radioactive	28
X	Incompatible with ALL other groups (phosphorous)	(*i.e.* 22)

The 23 groups listed in the CRC Handbook are available in **Appendix C**. *This table provides examples of each chemical hazard class and also lists the incompatible classes that should not be stored on the same shelf.*

6.3 Chemical Inventories

According to the PA state right-to-know act, a chemical inventory must be available to those working in each laboratory. Laboratory coordinators and PI have two options to choose from to comply with this and other state and federal regulations for chemical inventories. Lab members must have access via the online CNSM inventory or have access to a paper copy located in the aforementioned lab.

Option I:

This option is by far the easiest and will take the least amount of time on the part of the PI and / or lab coordinator. This option is also the automatically updated and requires less maintenance. PIs and lab coordinators can submit an Excel file containing a listing with the following information in columns: CAS number, Chemical Name, room number, shelf (optional), and amount contained in original bottle. The Excel file will be used to generate barcodes that will be placed on their respective bottles and the bottles will be entered into the CNSM inventory system.

Empty bottles or chemicals that are no longer desired are to be taken to room 146 where they will be removed from the inventory system. If laboratory members wish to conduct maintenance on their electronic inventory, the stockroom manager can print a list of bottles for each room by shelf as well as other reports. For more information on the online CNSM inventory system, please visit the online training located on Moodle.

Option II:

This option is for those members who do not wish to participate in the online inventory. A single paper copy, formatted from Excel, will be kept in its respective laboratory. Department offices will ensure that a single PDF file, containing all inventories by room number, is located on the R Drive under "Department Lab Inventories." The University Police, department chairs, department/college secretaries, and college safety officers will have access to this folder. All copies will be updated yearly by the PI or lab coordinator since the last yearly inspection. The paper copies will have the same format as the Excel file used to import chemicals into the online system; thus, the file will contain the following information in columns: CAS number, Chemical Name, room number, shelf (optional), and amount contained in original bottle. In the near future, after moving to the new building, all laboratories of the College will fall under Option I.

6.4 Federal, State, and Local Reporting of Chemicals and their Quantities

As stated throughout this document, the College is subject to numerous regulations beyond the OSHA Laboratory Standard. Below are some of the codes and regulations requiring that laboratory staff have knowledge of their chemical inventories.

EPCRA (Emergency Planning and Community Right-to Know Act) and CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) are a federal statutes that requires all entities that store, use or process hazardous chemicals to report this information to the State Emergency Response Commission and Local Emergency Planning Committees. The DHS (Department of Homeland Security) has issued regulations related to security of high risk chemical facilities. These regulations were released in the mid to late 2000's and require facilities to determine if they have specific chemicals above screening threshold quantities. While most of the time the College will be below these thresholds levels the College will monitor all levels of these chemicals. This data will be report to EH&S so that the University can gather a combine listing of all chemicals of interest; thereby aiding in the proper reporting. A listing of these chemicals can be found in Appendix E. Such reporting mechanisms have been included in the online CNSM inventory system.

The Indiana Fire Department through the Indiana Fire Codes requires entities that use hazardous materials to maintain inventories of all chemicals and to provide them upon request (*i.e.* during an emergency event such as a fire.). Therefore, Principal Investigators must maintain an up-to-date chemical inventory.

7.0 Chemicals and Drugs Used to Illicit a Biological Response

Use of FDA-approved drugs or experimental drugs in a clinical setting is outside the purview of this document. However, the safe handling and use of drugs in a laboratory setting must be described in the Laboratory Specific Safety Guide if the drug has the characteristics of a hazardous chemical or is a carcinogen and is in a form that has the potential to lead to an exposure. More broadly, *usage of any hazardous material for the purpose of eliciting a biological response must be covered by* the Laboratory Specific Safety Guide.

For animal experiments involving hazardous materials, it is the responsibility of the Principal Investigator to provide hazard communication information to animal care employees. This information will include, at a minimum:

- Identity of the material;
- Hazards associated with the material;
- Means that one should take to minimize exposure, including PPE and engineering controls;
- Location of SDSs;
- First aid response in the event of an exposure.

8.0 Drug Enforcement Agency (DEA) Scheduled Drugs

The Congress of the United States enacted into law the Controlled Substances Act (CSA) as Title II of the Comprehensive Drug Abuse Prevention and Control Act of 1970. Use of controlled substances in animal research is common in animal research where pain medication is required.

Use of controlled substances for research requires obtaining both federal (DEA) and state (PA Controlled Substances Board Special Use Authorization) registration. Penalties for using such drugs without proper registration can be severe. The regulations strictly limit who can handle or administer the drugs and imposes both physical security requirements as well as inventory requirements. Some key points concerning the regulations:

- The permitting process is between an individual researcher and the DEA and State;
- Registrants cannot share controlled substances with non-registered users who are not under their supervision (e.g., another research laboratory in their department);
- Possession of expired drugs also poses a risk to researchers from the USDA since administration of expired controlled substances is not allowed; and,
- Disposal is also strictly regulated. Only the DEA Special Agent in Charge can authorize the disposal of controlled substances.

The College has no role in the permitting process, though it can provide limited guidance upon request and funding for approvals. In certain instances the DEA may request that the registrant provide a letter stating that sewer disposal of a substance is acceptable by the county of Indiana.

9.0 Surplus Chemicals and Hazardous Waste

The Resource Conservation and Recovery Act (RCRA), enacted in 1976, is the principal Federal law in the United States governing the disposal of hazardous waste. RCRA is administered by the U.S. Environmental Protection Agency (EPA). In Pennsylvania the hazardous waste regulations are found in Chapter NR 662 "*Hazardous Waste Generator Standards.*"

The College strives to maintain compliance with all regulations regarding hazardous wastes while at the same time minimizing waste by a number of programs. Our waste minimization efforts include inventory reduction programs.

9.1 On-Site Hazardous Materials Management (OSHMM)

The Chemical Storeroom operates the college's On-Site Hazardous Materials Management (OSHMM) program. Surplus chemicals that are not designated as waste will be inventoried and stored for no more than 5 years in the stockroom or chemical storage facility.

9.2 In-Lab Chemical Management

As part of the chemical disposal process, Principal Investigators and laboratory staff are allowed to perform In-Lab Chemical Management of their inventories. In-Lab Chemical Management includes simple disposal and treatment methods that can be done in a lab, such as solvent commingling, flushing down the sanitary sewer (for non-hazardous chemicals), and neutralization.

Sanitary Sewer Disposal

The EPA does not allow IUP to sewer hazardous waste. Hazardous waste is usually classified as belonging to one of two groups: (1) characteristic hazardous waste (ignitable, corrosive, reactive or toxic) or (2) listed hazardous waste (K, F, P, U are the four lists published by EPA). However, the College is able to perform elementary neutralizations and dispose of the product in the sanitary sewer and sewer disposal of non-hazardous chemicals by complying with Indiana county.

It is essential that materials being sewered are water soluble and completely dissolved before going into the sink drain. Indiana county ordinances emphasize that materials that damage the pipes (corrosive), create an unsafe atmosphere (ignitable or toxic) in the line access points, block flow or interfere with the treatment process are prohibited. If you are in question whether a material should be disposed of in the sanitary sewer, it is preferred that you following normal waste streams rather than via the county sewer system.

Satellite Accumulation Areas

Federal regulations allow a waste generator to accumulate as much as 55 gallons of non-acute hazardous waste or one quart of acutely hazardous waste in containers at or near any point of generation and under the control of the operator. These storage locations are referred to as “Satellite Accumulation Areas” or SAAs and each laboratory is allowed one SAA. Requirements for laboratories maintaining SAAs include the following:

- There is no limit on the amount of time to accumulate the waste. However, once the 55 gallon container limit is met, the laboratory staff has 72 hours to have the container transferred to the university’s hazardous waste storage area.
- Containers must be marked either with the words "Used Chemicals" or with other words that identify the contents of the containers.
- Containers must be kept closed, except when adding/removing waste and must be handled in a manner that avoids ruptures and leaks.
- Personnel who generate waste or work in satellite accumulation areas need to be trained in waste handling and management, emergency procedures and other topics specific to that area. Typically this level of training is laboratory specific and should be held in conjunction with other required training.

Non-halogenated solvent waste must be collected separately from halogenated waste. While 55 gallons are allowed per SAA other regulations, such as the fire codes, may impose further limits on the number of bottles or carboys that can be stored in the laboratory.

Waste Removal from Accumulation Areas and Disposal

To ensure the safety of university students, faculty, and staff, as well as to comply with all federal, state, and local laws, the following should be used as a guide in preparing chemical waste for temporary storage in room 126A (Weyandt Hall) and removal from the IUP campus.

1. Enclose the chemical in a sealed container.
    a. Use only screw top chemical glassware or chemical industry approved plastic ware for disposal. These are available from the Science Stockroom, 146 Weyandt Hall.
        i. Soda pop, glass or plastic milk bottles, reaction flasks, Clorox bleach bottles, or rubber or glass stoppered containers will not be accepted.
        ii. Any container that is cracked or damaged in any way will not be accepted.

2. Apply a Used Chemicals label to the outside of the container and fill out the waste label as new materials are added to the bottle.
    a. Waste labels may be obtained from the Science Stockroom, 146 Weyandt Hall.
    b. Write either the common or the IUPAC name of each chemical. Do not use chemical abbreviations or structural formulas.

c. Provide the amount of each chemical. Estimate if the exact amount is not known.
d. Include the originator's name (advisor's name if student) and the date that bottle is transferred to the Science Stockroom.
e. Non-halogenated and halogenated compounds should not be mixed. Waste should be composed of only one layer (*i.e.* no aqueous systems and organic solvents in same bottle).
f. An individual chemical waste container, not containing a proper label, can cost IUP 3,000 to 5,000 dollars per bottle.

3. Waste bottles should be designated and separated by hazard class where each bottle contains only chemicals for their specified hazard class.

Organic	Corrosive (Acid)
Halogenated Organic	Corrosive (Base)
Reactive	Toxic
Oxidizer	Biomedical
Radioactive	Low Hazard

4. Full waste containers will be accepted in person only by the Stockroom Manager during normal stockroom hours. Waste bottles should not be left unattended in the Science Stockroom.
    a. Chemical wastes that are not properly prepared will not be accepted.
    b. Chemical waste containers should be full. Partially full containers will cost IUP the same as a full container. You do not need to evaporate any water that is present.
    c. The outside of the container should be devoid of waste residue.

5. It is recommended that chemical waste levels in teaching laboratories and research laboratories be checked at the end of each academic semester.

9.3 Laboratory Cleanouts and Clean Sweeps

The BSO, CSO, and RSO will assist with periodic laboratory cleanouts and departmental clean sweeps upon request. Clean sweeps provide opportunities for old and expired chemicals that may pose unnecessary risk to be removed. Contact the College stockroom for details.

As labs are vacated or as projects come to an end, PIs are required to remove all hazardous materials from the lab prior to their retirement or end date. Again, the BSO, CSO, and RSO will assist request. However, the departmental chair will be responsible for ensuring that all hazardous materials are removed prior to signing retirement paperwork.

10.0 Student and Employee Information and Training

The OSHA Laboratory Standard is clear on the requirement that all laboratory personnel receive the necessary information and training so that they understand the hazards of the materials present in their work area. The primary responsibility for ensuring this rests with the Principal Investigator, though College provides various online courses and classes to meet these needs. However, the lab-specific training must come from the Principal Investigator (or designated staff member). The Principal Investigator must ensure that the information and training is presented before laboratory workers are allowed to use or handle chemicals in their laboratory.

10.1 General Information for All Personnel

Laboratory personnel must be informed of:

- The contents of the Laboratory Standard and its appendices. Below is a link to the OSHA Laboratory Standard: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10106;
- The location and availability of the College Laboratory Safety Plan, The Departmental and Laboratory Specific Safety Plan;
- The permissible exposure limits for OSHA-regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard (see **Appendix C** of this document for more information);
- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and
- The location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory including, but not limited to, Safety Data Sheets received from the chemical supplier.

10.2 Employee Training

All new employees, upon their hiring, will receive a copy of the College Safety Plan along with access to the online training modules, available on the IUP Learning Management System (LMS). Employees will have access to the file and forms required by this safety plan via the LMS. The College Safety plan will be available from the College website. All files and forms will be available on the college drive.

10.3 Student Training

All students in teaching courses will receive general safety training at the start of each course as well as specific training on an as needed basis by the instructor of record for that course.

All students who 1) are a teaching assistant, 2) a laboratory preparer, or 3) choose continue research experiences beyond teaching labs will take the necessary College

Safety training. The student's Principle Investigator, research advisor, or supervisor will send the student to the LMS for training, tasking them with which modules to complete (Available Modules: Biological, Chemical, and/or Radiation). Students are required to complete training for hazards associate with their assigned duties and/or research. This typically requires more than one training module (i.e. if chemical are present in the work area, even if the student is not using them, the student will be required to take the Chemical Safety Training). After each module is completed, the student will receive an email, through the LMS, containing the respective certificate. The student will keep a hard copy of all certificates and provide a copy of each to their PI or supervisor.

All students working in labs will be required to review and sign, with their PI or supervisor, the Student Orientation Checklist prior to working in the lab. This form too will be kept as a hard copy by both the PI/Supervisor and the student. These forms are available on the LMS.

Students must show proof of their College safety training at the time of requesting a laboratory key by showing completed training certificates. The PI or supervisor will update the Laboratory Personnel listing that is to be maintain just inside the research space (CNSM 2013-11).

The College offers training on general laboratory safety through the BSO, CSO, and RSO online via Moodle. This covers details of the OSHA Laboratory Standard as well as College safety policies, resources, and services.

10.4 Laboratory-Specific Training

Laboratory members must also receive training on the laboratory-specific operations. This must include:

- The specific classes of physical and health hazards (e.g., corrosive, carcinogenic, flammable, water-reactive chemicals) associated with the hazardous chemicals staff may come in contact with in the laboratory where they work;
- The methods that are to be used to control these hazards, including engineering and administrative controls, and personal protective equipment;
- Any laboratory-specific emergency procedures and the location and proper use of safety equipment (e.g., fume hood, fire extinguisher, emergency eyewash, and shower).

Typically this training is provided by the Principal Investigator or other experienced laboratory staff member. Training must be communicated in a manner readily understood to those being trained. This may require written as well as oral transmission of information. The frequency of refresher training and information can be determined by the Principal Investigator. Refer to Laboratory Safety Plan for information on documentation requirements.

11.0 Emergency Response

Each Principal Investigator must ensure that all laboratory staff is knowledgeable and trained on emergency procedures. Many of the procedures are covered in other campus plans, including a building's Occupant Emergency Plan (OEP). The OEP is an all-hazard plan designed around a building's unique layout and function. The primary purpose of the OEP is to provide guidance to building occupants in the event of an emergency, such as a tornado, active shooter, gas leak or bomb threat.

Assess the hazards present in your workspace and tailor your emergency equipment and response plans accordingly. Emergency response plans should be developed covering lab-specific procedures, including:

- Procedures for handling small and large chemical spills;
- Procedures for handling instrument failures;
- Procedures for handling ventilation failures; and
- Procedures for responding to local alarms, such as oxygen or toxic gas sensors.

In case of an emergency, be prepared to follow the planned emergency procedures for your workplace and building. Before an emergency strikes, there are several things that can be done to improve preparedness.

- Review your building's emergency plans, taking note of proper exit and reentry procedures and emergency contacts. Make sure these procedures and contacts are visibly posted and that all employees are familiar with them.
- Check your Laboratory Emergency Information Card (located near the laboratory entrance) and make sure the information is up to date. Keep your SDS files up to date and easily accessible.
- Locate and become knowledgeable with important emergency equipment in the laboratory such as fire extinguishers, eyewash stations, and spill kits. Have several of the laboratory employees trained on proper use of first aid and fire extinguishers.
- Periodically check the emergency equipment to make sure it is properly maintained, appropriate for the hazard and ready for use. For example, eyewash stations need to be flushed weekly to make sure the water is clean and adequately dispensed. Also, if you have acids in the lab, a spill kit for flammable liquids will be insufficient.
- Have emergency contacts posted:
  IUP Police: 911
  Indiana Regional Hospital: (724) 357-7000
  American Association of Poison Control: 1 (800) 222-1222

Dialing **9-911** on a campus landline phone or **911** from a cell phone will go directly to the Indiana County dispatch. Dialing **7-2141** on a campus landline phone or **(724) 357-2141** from a cell phone will go directly to the IUP Police. There are also Blue Emergency Phone located in the hallways that directly call the IUP Police when the handset is picked up.

12.0 Exposure Monitoring

Pennsylvania State regulations require exposure monitoring where exposure may occur at or above a published exposure value of OSHA or ACGIH (American Conference of Governmental Industrial Hygienists). Examples of such values could include the action level, permissible exposure level, threshold limit value, short-term exposure limit or ceiling limit. If you believe that you are being exposed to levels above the permissible limits, contact the CSO. The correct personnel will provide consultation and, if deemed appropriate, will perform the necessary exposure monitoring. The affected College staff will be notified of the results within 15 days of receipt of the results.

13.0 Respiratory Protection

As stated above, it is the policy of the College to take all prudent steps to minimize exposures to hazardous materials. This is primarily achieved by prudent experimental design and engineering controls. Examples include eliminating the hazard by substituting for a less hazardous alternative or containing the hazard through ventilation or other controls.

If no alternatives can be found, then respiratory protection *may* be required. Before using a respirator, a Respiratory Protection Plan must be developed with University EH&S. The written program identifies who will be responsible for administering the respirator program in your laboratory or department. In addition, the website will detail how other obligations will be met such as medical surveillance, fit testing equipment selection and maintenance.

14.0 Medical Consultations and Evaluations

The university offers access to medical evaluation and associated services under the following circumstances:

- Signs or symptoms of exposure to chemical used in the laboratory are experienced;
- Exposure to an agent repeatedly occurs above a permissible level;
- A spill or release occurs resulting in agent exposure; and,
- Respirator use is required when working with the agent.

In addition to the circumstances listed above, there may be other occasions when consultation with either your personal physician may be warranted. Examples of such conditions may include pregnancy, desire to conceive or existence of a health condition which may put you at greater risk. In the event of a possible exposure, the affected individual (or other laboratory staff present) must be prepared to supply the following information:

- The identity of the hazardous chemical(s) to which the worker may have been exposed;

- A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and
- A description of the signs and symptoms of exposure that the worker is experiencing, if any.

15.0 Laboratory Visitation Program

The Laboratory Visitation Program is an ongoing program that provides assistance and consultation to help create a safe work environment. As part of the visit, EH&S staff and/or CNSM Safety Committee members will help insure all College, University and governmental regulations are being complied with in the laboratories. The Laboratory Visitation Team performs a review of all safety documentation and physical hazards which include fire safety, chemical safety, engineering controls, and safety training. Upon completion of the laboratory visit, a report is issued to each laboratory manager. This report outlines areas that need improvement as well as any necessary guidance documents.

16.0 Incident/Accident Notification Investigation

Principal Investigators and supervisors must report any incident involving personal injury, exposure or illnesses, property damage or incidents involving an environmental release of hazardous materials using the Injury report form (form CNSM 2013-01).

A primary tool to identify and recognize the areas responsible for accidents is a thorough and properly completed accident investigation. Accident investigations shall be conducted by the EH&S staff and/or the College Safety Committee members with the primary focus of understanding why the accident or near miss occurred and what actions can be taken to preclude recurrence.

Procedures for investigating workplace accidents and hazardous materials exposures include:

- Visiting the accident scene as soon as possible;
- Interviewing injured workers and witnesses;
- Examining the workplace for factors associated with the accident/exposure;
- Determining the cause of the accident/exposure;
- Taking corrective action to prevent the accident/exposure from reoccurring;
- Recording the findings and corrective actions taken.

The investigation will be recorded in writing and will adequately identify the cause(s) of the accident or near-miss occurrence. Documentation of the investigation and all follow-ups will be prepared and maintained by a member of the EH&S staff and/or College Safety Committee member performing the investigation.

17.0 Transportation and Shipping of Hazardous Materials

17.1 Shipping of Hazardous Materials

In order to protect the public at large, the US Department of Transportation (DOT) regulates the shipping and transportation of hazardous materials *in commerce* on roadways and airways. A hazardous material is defined as any substance or material that could adversely affect the safety of the public, handlers or carriers during transportation. All DOT hazardous materials are listed in the DOT's Hazardous Material Table:

http://setonresourcecenter.com/transportation/49CFR/172_101tb.pdf

The regulations for shipping hazardous materials apply to all individuals involved in the shipping process, including individuals who:

- Arrange for transport;
- Package materials;
- Mark and label packages;
- Prepare shipping papers;
- Handle, load, secure and segregate packages within a transport vehicle.

Non-compliance with these standards is subject to civil penalties up to $50,000 per violation and up to $100,000 if death, serious illness, severe injury to any person or substantial destruction of property. Criminal penalties may result in penalties up to 10 years imprisonment. The requirements can be found in 49 CFR Parts 171-178 and cover the documentation, packing, marking, and labeling of hazardous materials as well as the training of shippers, carriers, and handlers. International Air Transport Association (IATA) regulations also apply when shipping hazardous chemicals by common air carriers such as FedEx since these carriers require that IATA rules are met.

17.2 On-Campus Transportation of Hazardous Materials

Under the current regulations, IUP is considered a government agency; therefore university employees transporting hazardous materials are not technically placing the materials "in commerce." As a result, university employees transporting hazardous materials between campus buildings on public roadways are exempt from the DOT Hazardous Material Regulations (i.e. the normal packaging, labeling, placarding, and documentation do not apply). However, individuals who move hazardous chemicals on campus are still subject to the following university requirements:

- The employees involved in moving the hazardous materials should be trained and familiar with its hazards and basic handling properties.
- Before moving the material, an emergency plan and spill kit must be available in case of an accident or environmental discharge.
- Secondary containment of hazardous materials must be used for all materials where there is a potential for a spill.

- Only university vehicles (i.e., not personal vehicles) can be used for the transportation of hazardous materials. The transportation of liquid nitrogen is exempt from this requirement.

Hazardous waste is regulated by the US Environmental Protection Agency (EPA) in 40 CFR 260-265. The transportation of waste requires special marking, training, and documentation. Hazardous waste can only be transported by IUP EH&S employees and approved contractors.

18.0 Laboratory Inspections

The following items will be tested or inspected in every room where the handling of hazardous materials occurs.

18.1 Eyewash Station and Safety Shower Inspections

Eyewash and safety showers will be inspected by EH&S staff each semester in accordance with the timeline listed in Table 2. As with the laboratory inspections, an email will be sent prior to the inspections so that employees may be present. Each station's inspection tag will be signed after a successful testing and a list documenting the room number of those stations passing inspection will be sent to the CSO for documentation and record keeping. A work order for any station not able to pass testing will be placed. Upon completion these previously non-working stations will be retested. No work with hazardous materials may take place while the station is out of service.

18.2 Chemical Fume hood Inspections

Chemical Fume hoods will be inspected yearly by EH&S staff in accordance with the timeline in Table 2. As with the laboratory inspections, an email will be sent prior to the inspections so that employees may be present. Each fume hood that passes inspection will receive an inspection sticker that has been properly filled out. A list, documenting the room number with hood letters (*i.e.* A, B, C), of those fume hoods passing inspection will be sent to the CSO for documentation and record keeping. A work order for any fume hood not able to pass inspection will be placed. Upon completion these previously non-working fume hoods will be retested prior to the end of the academic year. No work with hazardous materials may take place in the fume hood while the fume hood is out of service.

18.3 Laboratory Air Exchange Inspections

IUP EH&S will determine the air exchange of each room that maintains or uses hazardous materials every five years as contained in Table 2. The proper exhaust of airborne materials is a great engineering control that can afford clean air for building occupants. Airflows into the laboratories should be measured as well as the determination of where the air in the room goes. It is just as important to ensure that contaminated air has the proper avenues to be removed and not simply dumped into a hallway. Providing clean, fresh, and contaminant free air is a prominent concern for any building on campus and his is especially true for buildings containing hazardous, possibly carcinogenic materials.

18.4 Laboratory Inspections

All teaching and research laboratories in the CNSM will be inspected yearly according to Table 2. EH&S staff will send an email to all CNSM employees to announce their yearly inspection. At that time, if any employee wishes to be present for the inspection of areas under their responsibility, they can reply and setup a time within the inspection period. A lab may be inspected more often if deemed necessary by EH&S.

Upon completion of the laboratory inspections, inspection forms (CNSM 2013-04) will be turned into each department chair. Department chairs and Pis will be responsible for ensuring that any and all deficiencies have been corrected, if any, by their signature on the inspection form. Department Chairs will forward completed forms to the Deans office per Table 2.

EH&S staff will evaluate each laboratory storage pattern at each yearly inspection and will update as needed. Storage patterns for each lab will be turned into the CSO for documentation and referral with the IFD during an emergency.

18.5 College Safety Timeline by Academic Year

Table 2 provides an overview of the timetable for the safety items contained in this safety plan.

Table 2. Inspection Timeline.

Item	Month											
	Aug	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**
IUP EH&S												
Chemical Fume Hood Inspections			**X**	**X**	**X**							
Inspect Eyewash Station and Safety Showers		**X**						**X**				
Air Exchange Study of Teaching and Research Labs (Every 5 years, *i.e.* ’00 and ’05)								**X**	**X**	**X**		
Fire Extinguisher Inspections		**X**										
Laboratory Inspections							**X**	**X**				
College Safety Committee												
Update College Safety Plan										**X**	**X**	**X**
Collect and Review/File Inspection Forms						**X**				**X**	**X**	
Publish Lists of Passing Safety Tests on Moodle Site(Bio, Chem, and Radiation)	**X**				**X**		**X**			**X**		
Each Department (Chair)												
Update Department Specific Safety Plan		**X**										
Update Lab Emergency Contact Sheet		**X**										
Ensure Lab Inspection Forms Signed and Fwd. to Deans Office									**X**			
Each Principal Investigator												
Update Laboratory Specific Safety Plan (Optional)		**X**										
Update Refrigerator Emergency Contact Sheet (Only if change)		**X**										
Update Chemical Storage Pattern Card (Only if change)		**X**										
Research Student College Safety Training Form (As needed)												
Research Student Orientation Checklist (As needed)												
Post and Update Research Personnel Form (As needed)												

19.0 Records

Principal Investigators are required to maintain all of their student and staff records associated with their laboratories. These records include:

- Copies of Laboratory Specific Safety Guide and any laboratory SOPs;
- A listing of laboratory personnel will be posted near the research laboratory entrance (Form NSM 2013-11).
- Training records for laboratory personnel (Forms CNSM 2013-03 and CNSM 2013-10);

Students will maintain a copy of their College Safety Training certificates for the sections which they pass (Biology, Chemistry, and Radiation) as proof of training received.

Records of inspection results performed by EH&S staff will be maintained by the CSO. Examples of inspection records include: fume hood inspections, eyewash and safety shower inspections, and laboratory inspections. Fire extinguisher inspections will be kept with IUP EH&S. A master list of those students who have successfully passed each section (Biology, Chemistry, and Radiation) will be posted on Moodle according to the timeline in Section 18.5 above.

Appendix A: Exposure Limits

Laboratories as workplaces pose unique hazards. There is the potential for exposure to a large number of chemicals but exposures, if they do occur, tend to be of short duration. All prudent steps should be taken to minimize exposure, but the steps should be risk based. Various occupational exposure limits have been set by organizations. Some of the limits are enforceable by law while others are recommendations only, with no legal bases. These limits still perform a needed function in aiding an informed risk assessment process. Below is some information on the major occupational exposure limits.

Permissible Exposure Limits (PELs):

OSHA sets enforceable permissible exposure limits (PELs) to protect workers against the health effects of exposure to hazardous substances. PELs are regulatory limits on the amount or concentration of a substance in the air. They may also contain a skin designation that serves as a warning of potential cutaneous absorption that should be prevented in order to avoid exceeding the absorbed dose received by inhalation at the permissible exposure level (PEL). Most OSHA PELs are based on an 8-hour work shift of a 40-hour workweek time weighted average (TWA) exposure that an employee may be exposed to for a working lifetime without adverse effects. Some of the PELs are listed as ceiling values – concentrations above which a worker should never be exposed. To locate PELs on specific chemicals go to:

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992

Threshold Limit Value (TLV®):

Threshold Limit Values (TLV) are occupational exposure limits set by the American Conference of Governmental Industrial Hygienists (ACGIH). The time-weighted average TLV (TWA-TLV) is an airborne concentration of a gas or particle to which most workers can be exposed on a daily basis for a working lifetime without adverse effect (assuming an average exposure on the basis of a 8h/day, 40h/week work schedule). In addition ACGIH define:

- Short-term exposure limits (TLV-STEL) which are concentrations above which a worker should not be exposed (averaged over 15 minutes). Exposures cannot be repeated more than 4 times per day;
- Ceiling limits (TLV-C) which are concentrations above which a worker should never be exposed.

Recommended Exposure Limits (RELs)

Recommended Exposure Limits (RELs) were developed the National Institute for Occupational Safety and Health (NIOSH). NIOSH is the principal federal agency engaged in research, education, and training related to occupational safety and health. The REL is a level that NIOSH believes would be protective of worker safety and health over a working lifetime if used in combination with engineering and work practice controls, exposure and medical monitoring, posting and labeling of hazards, worker training and personal protective equipment. RELs are not legally enforceable.

NIOSH is well known for its *NIOSH Pocket Guide to Chemical Hazards.* In addition to containing RELs, it also has information on incompatibilities and reactivities, exposure routes, symptoms of exposure, target organs, potential cancer site, PPE, and first aid. A searchable version of the guide can be found at http://www.cdc.gov/niosh/npg/.

Immediately Dangerous to Life or Health (IDLH)

NIOSH also provides concentrations for chemicals that it considers immediately dangerous to life or health (IDLH). NIOSH defines an IDLH condition as a situation "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment." IDLH values can be found in the *NIOSH Pocket Guide to Chemical Hazards*.

Workplace Environmental Exposure Levels (WEELs)

The American Industrial Hygiene Association (AIHA) develops worker exposure levels for health-based chemicals. Since most of the other worker protection limits are for commonly used industrial chemicals AIHA began developing Workplace Environmental Exposure Levels to meet a specific need. The latest WEELs can be found at:

http://www.aiha.org/insideaiha/GuidelineDevelopment/weel/Documents/WEEL_Values2010.pdf

Appendix B: CRC Handbook's Storage Classes

Table B1. Storage Classes Suggested by the CRC Handbook.

Group	Name	Example	Incompatible Groups
Group 1	Inorganic Acids	Hydrochloric acid Hydrofluoric acid Hydrogen chloride Hydrogen fluoride Nitric acid Sulfuric acid Phosphoric acid	2,3,4,5,6,7,8,10,13,14,16,17,18,19,21,22, 23
Group 2	Organic acids	Acetic acid Butyric acid Formic acid Propionic acid	1,3,4,7,14,16,17,18,19,22
Group 3	Caustics	Sodium hydroxide Ammonium hydroxide solution	1,2,6,7,8,13,14,15,16,17,18,20,23
Group 4	Amines and Alkanolamines	Aminoethylethanolamine Aniline Diethanolamine Diethylamine Dimethylamine Ethylenediamine 2-Methyl-5-ethylpyridine Monoethanolamine Pyridine Triethanolamine Triethylamine Triethylenetetramine	1,2,5,7,8,13,14,15,16,17,18,23
Group 5	Halogenated Compounds	Allyl chloride Carbon tetrachloride Chlorobenzene Chloroform Methylene chloride Monochlorodifluoromethane 1,2,4-Trichlorobenzene 1,1,1-Trichloroethane Trichloroethylene Trichlorofluoromethane	1,3,4,11,14,17

Group 6	Alcohols Glycols Glycol Ether	1,4-Butanediol Butanol (iso, n, sec, tert) Diethylene glycol Ethyl alcohol Ethyl butanol Ethylene glycol Furfuryl alcohol Isoamyl alcohol Methyl alcohol Methylamyl alcohol Propylene glycol	1,7,14,16,20,23
Group 7	Aldehydes Acetaldehyde	Acrolein Butyraldehyde Crotonaldehyde Formaldehyde Furfural Paraformaldehyde Propionaldehyde	1,2,3,4,6,8,15,16,17,19,20,23
Group 8	Ketones	Acetone Acetophenone Diisobutyl ketone Methyl ethyl ketone	1,3,4,7,19,20
Group 9	Saturated Hydrocarbons	Butane Cyclohexane Ethane Heptane Paraffins Paraffin wax Pentane Petroleum ether	20
Group 10	Aromatic Hydrocarbons	Benzene Cumene Ethyl benzene Naphtha Naphthalene Toluene Xylene	1,20

Group 11	Olefins	Butylene 1-Decene 1-Dodecene Ethylene Turpentine	1,5,20
Group 12	Petroleum Oils	Gasoline Mineral Oil	20
Group 13	Esters	Amyl acetate Butyl acetates Castor oil Dimethyl sulfate Ethyl acetate	1,3,4,19,20
Group 14	Monomers Polymerizable Esters	Acrylic acid Acrylonitrile Butadiene Acrylates	1,2,3,4,5,6,15,16,19,20,21,23
Group 15	Phenols	Carbolic acid Cresote Cresols Phenol	3,4,7,14,16,19,20
Group 16	Alkylene Oxides	Ethylene oxide Propylene oxide	1,2,3,4,6,7,14,15,17,18,19,23
Group 17	Cyanohydrins	Acetone cyanohydrin Ethylene cyanohydrin	1,2,3,4,5,7,16,19,23
Group 18	Nitriles	Acetonitrile Adiponitrile	1,2,3,4,16,23
Group 19	Ammonia	Ammonium Hydroxide Ammonium Gas	1,2,7,8,13,14,15,16,17,20,23
Group 20	Halogens	Chlorine Fluorine	3,6,7,8,9,10,11,12,13,14,15,19,21,22
Group 21	Ethers	Diethyl Ether THF	1,14,20
Group 22	Phosphorus	Phosphorus, Elemental	1,2,3,20
Group 23	Acid Anhydrides	Acetic anhydride Propionic anhydride	1,3,4,6,7,14,16,17,18,19

Appendix C: Particularly Hazardous Substances

When working with hazardous materials, laboratory personnel need to understand the risks associated with the chemicals. Once the hazards are known then steps can be taken to minimize the risk associated with the hazard. Such steps include appropriate PPE and engineering controls, such as fume hoods. OSHA requires that special provisions be taken when working with Particularly Hazardous Substances (PHSs) since these substances potentially pose a higher health risk. PHSs are, according to OSHA, "select carcinogens", reproductive toxins, or substances that have a high degree of acute toxicity.

The OSHA requirements for working with PHSs are more a matter of degree than a clear-cut differentiation from other substances. Risk assessments must always be done. The Laboratory Standard simply requires that higher risk materials be identified and mandates that extra precautions be used, if appropriate.

Laboratory personnel must do their due diligence when planning an experiment or procedure to determine hazards. This appendix provides some information and links to resources that help you identify PHSs. It is impossible to provide a master list of all PHSs so the information below should not be considered as comprehensive. This is especially true at a research institution where exotic materials are used for which there is no toxicological information. Also, toxicity is often related to the chemical's form and how it is used. For example, compounds which are not considered highly dangerous may pose a much greater risk in the form of a nanoparticle. It is for this reason that prudent practices should always be taken to minimize exposures.

Carcinogens

"Select carcinogens" are any substances that meet one of the following criteria:

- It is regulated by OSHA as a carcinogen; or
- It is listed under the category "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP; latest edition); or
- It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC; latest edition); or
- It is listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP.

The National Toxicology Program has a website that provides the most recent list of materials known or reasonably anticipated to be carcinogenic. The website also provides a profile for each of the chemicals summarizing the carcinogenicity, properties, uses, and exposure routes for the substance. The website can be accessed at:

http://ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932

A list of all the materials for which the IARC has issued reports can be found at the following website:

http://monographs.iarc.fr/ENG/Classification/ClassificationsAlphaOrder.pdf

This site also indicates the category the material falls under, with Group 1, 2A, and 2B being the chemicals of greatest concern.

Reproductive Toxins

Reproductive toxins, according to OSHA, are chemicals that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). The Environmental Health and Safety Office at the University of Hawaii at Manoa has compiled a list of select carcinogens on their website. This can be found at: http://www.hawaii.edu/ehso/lab/list.htm.

Highly Toxic Compounds

OSHA defines substances that have a high degree of acute toxicity as substances that are "fatal or cause damage to target organs as a result of a single exposure or exposures of short duration". IUP, like many institutions, applies the OSHA Hazard Communication Standard for highly toxic substances. According to OSHA, a chemical falling within any of the following categories is considered to be highly toxic:

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

A complete list of all highly toxic compounds is impossible to compile. The compounds listed below were obtained from Penn State University. This list is provided as an aid. Laboratory personnel must still do their due diligence when performing a risk assessment. Consult other sources whenever possible. The SDS should also be consulted as it often has NFPA or HMIS health ratings for the compounds.

Table C1. List of Highly Toxic Compounds

COMPOUND	CAS #
ACETONE CYANOHYDRIN (DOT)	75-86-5
ACETONYLBENZYL)-4-HYDROXYCOUMARIN, 3-	81-81-2
(ALPHA-ACROLEIN, INHIBITED (DOT)	107-02-8
ACTIDIONE	66-81-9
ACTINOMYCIN D	50-76-0
AFLATOXINS	1402-68-2
ALDRIN (DOT)	309-00-2
ALLYL BROMIDE (DOT)	106-95-6
ALLYL ISOTHIOCYANATE	57-06-7
ALLYLIDENE DIACETATE	869-29-4
ALUMINUM PHOSPHIDE (DOT)	20859-73-8
AMINO PYRIDINE, 2-	504-29-0
AMINOPTERIN	54-62-6
AMINOPYRIDINE, 4-	504-24-5
ANTU (NAPHTHYLTHIOUREA, ALPHA-)	86-88-4
ARSENIC ACID, SODIUM SALT (SODIUM ARSENATE)	7631-89-2
ARSENIC ACID, SOLUTION	7778-39-4
ARSENIC IODIDE	7784-45-4
ARSENIC PENTASULFIDE	1303-34-0
ARSENIC PENTOXIDE (DOT)	1303-28-2
ARSENIC TRICHLORIDE	7784-34-1
ARSENIC TRIOXIDE	1327-53-3
ARSENIC TRISULFIDE	1303-33-9
ARSENIOUS ACID (ARSENIC TRIOXIDE, SOLID)	1327-53-3
ARSENIOUS OXIDE (ARSENIC TRIOXIDE, SOLID)	1327-53-3
ARSINE	7784-42-1
AZINPHOS-METHYL	86-50-0
AZIRIDINE	151-56-4
BAY 25141	115-90-2
BENZEDRINE	300-62-9
BENZENETHIOL (PHENYL MERCAPTAN) (DOT)	108-98-5
BIDRIN	141-66-2
BORON TRIFLUORIDE	7637-07-2
BUSULFAN	55-98-1
BUTANEDIOL DIMETHYLSULFONATE, 1,4-	55-98-1
BUTYL-4,6-DINITROPHENOL, 2-SEC-	88-85-7
CALCIUM ARSENATE, SOLID	7778-44-1
CALCIUM CYANIDE	592-01-8
CARBON OXYFLUORIDE	353-50-4
CARBONYL CHLORIDE	75-44-5
CARBONYL FLUORIDE	353-50-4
CARBONYL SULFIDE	463-58-1
CHLORINATED DIPHENYL OXIDE	31242-93-0
CHLORINE (DOT)	7782-50-5
CHLORINE PENTAFLUORIDE	13637-63-3
CHLORINE TRIFLUORIDE	7790-91-2
CISPLATIN	15663-27-1
CYANOGEN	460-19-5

CYANOGEN CHLORIDE	506-77-4
CYCLOHEXIMIDE	66-81-9
CYCLOPHOSPHAMIDE	50-18-0
DASANIT	115-90-2
DAUNOMYCIN	20830-81-3
DDVP (DICHLORVOS)	62-73-7
DEMETON, MIXED ISOMERS	8065-48-3
DICHLORO-N-METHYLDIETHYLAMINE, 2,2'-	51-75-2
DICHLORVOS	62-73-7
DICROTOPHOS	141-66-2
DIELDRIN (DOT)	60-57-1
DIETHYL S-[2-(ETHYLTHIO)ETHYL]PHOSPHORODITHIOATE, O-	298-04-4
DIETHYLHYDRAZINE, 1,2-	1615-80-1
DIISOPROPLY FLUOROPHOSPHATE	55-91-4
DIMETHYL MERCURY	593-74-8
DINITRO-O-CRESOL, 4,6-	534-52-1
DINITROPHENOL, 2, 4-	51-28-5
DINOSEB	88-85-7
DIOXATHION	78-34-2
DISULFOTON	298-04-4
DNBP	88-85-7
ENDOSULFAN	115-29-7
ENDRIN	72-20-8
EPN	2104-64-5
ETHION	563-12-2
ETHYLENEIMINE (DOT)	151-56-4
FENAMIPHOS	22224-92-6
FENSULFOTHION	115-90-2
FLUOROACETIC ACID, SODIUM SALT	62-74-8
FONOFOS	944-22-9
GLYCOLONITRILE	107-16-4
GUTHION	86-50-0
HEPTACHLOR	76-44-8
HEPTACHLOR EPOXIDE	1024-57-3
HYDROCYANIC ACID, LIQUIFIED	74-90-8
HYDROGEN CHLORIDE GAS	7647-01-0
HYDROGEN CYANIDE	74-90-8
HYDROGEN FLUORIDE GAS	7664-39-3
HYDROXY-3(3-OXO-1-PHENYLBUTYL)-2H-1-BENZOPYRAN-2-ONE	81-81-2
IRON PENTACARBONYL	13463-40-6
LANNATE	16752-77-5
MELPHALAN	148-82-3
MERCURIC CHLORIDE	7439-97-6
METHYL CYCLOPENTADIENYL MANGANESE TRICARBONYL, 2-	12108-13-3
METHYL HYDRAZINE	60-34-4
METHYL IODIDE	74-88-4
METHYL MERCURY	593-74-8
METHYL PARATHION, LIQUID	298-00-0
METHYL VINYL KETONE, INHIBITED (DOT)	78-94-4
METHYL-BIS(2-CHLOROETHYL) AMINE (NITROGEN MUSTARD), N-	51-75-2

METHYL-N-NITROSO-METHANAMINE,N-	62-75-9
METHYLAZIRIDINE, 2- (PROPYLENEIMINE, INHIBITED)	75-55-8
METHYLHYDRAZINE (DOT)	60-34-4
METHYLPROPYL)-4,6-DINITRO-PHENOL,2-(1-	88-85-7
MEVINPHOS	7786-34-7
MITOMYCIN C	50-07-7
MONOCROTOPHOS	6923-22-4
MYLERAN	55-98-1
NAPHTHYLTHIOUREA, ALPHA-	86-88-4
NITROGEN MUSTARD	51-75-2
NITROSODIMETHYLAMINE, N-	62-75-9
PARAQUAT, RESPIRABLE FRACTION	2074-50-2
PERFLUOROISOBUTYLENE	382-21-8
PHENYL MERCAPTAN (DOT)	108-98-5
PHENYLPHOSPHINE	638-21-1
PHORATE	298-02-2
PHOSDRIN (MEVINPHOS)	7786-34-7
PHOSGENE	75-44-5
PHOSHONOTHIOIC ACID, O-ETHYL O-(P-NITROPHENYL)ESTER,	2104-64-5
PHOSPHINE	7803-51-2
PHOSPHORUS PENTAFLUORIDE	7641-19-0
POTASSIUM CYANIDE, SOLID (DOT)	151-50-8
PREMERGE	88-85-7
PROPANENITRILE	107-12-0
PROPIONITRILE	107-12-0
PROPYLENEIMINE, INHIBITED (DOT)	75-55-8
SODIUM AZIDE	26628-22-8
SODIUM CYANIDE, SOLID (DOT)	143-33-9
STRYCHNINE, SOLID (DOT)	57-24-9
SULFOTEP	3689-24-5
SYSTOX	8065-48-3
TETRACHLORODIBENZO-P-DIOXIN, 2,3,7,8- (TCDD)	1746-01-6
TETRAETHYL DITHIOPYROPHOSPHATE (TEDP)	3689-24-5
TETRAETHYL LEAD, LIQUID	78-00-2
TETRAETHYLPYROPHOSPHATE, LIQUID	107-49-3
THIODAN (ENDOSULFAN)	115-29-7
THIOPHENOL (PHENYL MERCAPTAN) (DOT)	108-98-5
TRIETHYLENETHIOPHORAMIDE, N,N',N''-	52-24-4
TRIMETHYLENETRINITRAMINE	121-82-4
URACIL MUSTARD	66-75-1
VANADIUM PENTOXIDE	1314-62-1
VAPATONE (TETRAETHYLPYROPHOSPHATE, LIQUID)	107-49-3
WARFARIN	81-81-2

Appendix D: Chemical Storage Limits

The College is subject to the International Fire Code (IFC), by virtue of it being adopted by the Indiana Fire Department (IFD), as well as the International Building Code since the State of Pennsylvania has adopted the 2006 version. MFD also enforces sections of the National Fire Protection Association (NFPA) standards since these have been adopted by IFC reference.

The tables in this section attempt to portray the limits that are imposed by the codes mentioned above. The maximum allowable quantities (MAQs) listed below are per control area. As discussed above, a laboratory is not necessarily a control area – it may consist of more than one laboratory. Also, fire codes are not necessarily applied retroactively unless significant remodeling of the facility has occurred.

Table D1. This table provides a list of MAQs based on the class of material. The table includes storage limits and limits for usage in an open or closed system. IFC defines "open" and "closed" systems as the following:

OPEN SYSTEM. The use of a solid or liquid hazardous material involving a vessel or system that is continuously open to the atmosphere during normal operations and where vapors are liberated, or the product is exposed to the atmosphere during normal operations. Examples of open systems for solids and liquids include dispensing from or into open beakers or containers, dip tank and plating tank operations.

CLOSED SYSTEM. The use of a solid or liquid hazardous material involving a closed vessel or system that remains closed during normal operations where vapors emitted by the product are not liberated outside of the vessel or system and the product is not exposed to the atmosphere during normal operations; and all uses of compressed gases. Examples of closed systems for solids and liquids include product conveyed through a piping system into a closed vessel, system or piece of equipment.

Additional definitions are supplied at the end of this Appendix. When viewing Table D1 note the footnotes below the Tables. These indicate building or containment features that may increase the MAQs or, in some instances, are required. Table D1 assumes the laboratory is on the ground floor.

Table D1. International Fire Code (IFC 2003) Maximum Allowable Quantities (MAQ) In Storage per Fire Control Areas

Hazardous Material	Class	Storage	Use (open system)
Flammable Liquid (gallons)	IA IB or IC	30[1,2] 120[1,2]	10[1] 30[1]
Combustible liquids (gallons)	II IIIA	120[1,2] 330[1,2]	30[1,] 80[1,]
Flammable gas, gaseous (cubic feet)		1000[1,2]	NA
Flammable gas, liquefied (pounds)		30[1,2]	NA
Flammable solid (pounds)		125[1,2]	NA
Cryogenics, flammable (pounds)		45[1]	10
Cryogenics, oxidizing (pounds)		45[1]	10
Organic peroxide (pounds)	UD I II	1[2,4] 5[1,2] 50[1,2]	0.25[4] 1[1] 10[1]
Highly Toxic, gases (cubic feet)		20[3]	3[3]
Highly Toxic, liquids (gallons)		10	3
Highly Toxic (pounds)		10	3
Toxic, gases (cubic feet)		810	810
Toxic, liquids (gallons)		500	500
Toxic (pounds)		500	125
Oxidizing gas, gaseous		1500[1,2]	NA

Hazardous Material	Class	Storage	Use (open system)
(cubic feet)			
Oxidizing gas, liquefied (pounds)		NA	NA
Pyrophoric materials (pounds)		8[2,4]	0[2,4]
Pyrophoric materials gaseous (cubic feet)		100[2,4]	0[2,4]
Unstable (reactive) (pounds)	4 3 2	2[1,4] 20[1,2] 200[1,2]	0.25[4] 1[1] 50[1]
Water reactive (pounds)	3 2	5[1,2] 50[1,2]	1[1] 10[1]
Corrosive (cubic feet)		810	100
Highly toxic (cubic feet) (needs EH& S) approval		20	20
Toxic (cubic feet)		810	25

NA = Not applicable; a cubic foot = 0.023 m^3; 1 pound = 0.454 kg.; 1 gallon = 3.785 L.

o) Maximum quantities shall be increased 100% (Table D1) for buildings equipped throughout with an automatic sprinkler. Where note 2 also applies the increase for both notes are to be applied accumulatively. 2) Maximum allowable quantities are to be increased up to 100% when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in IFC. Where note 1 also applies the increase for both notes are to be applied accumulatively.3) Allowed only when stored in approved exhausted gas cabinets or exhausted enclosures as specified in the International Fire Code. 4) Permitted only in buildings equipped throughout with an automatic sprinkler system.

Additional Notes:
1) The combined amounts of all classes (IA, IB, and IC) of flammable liquids cannot exceed the limits for the limits stated for (IB and IC).
2) For chemicals that fit into multiple categories, the most restrictive limits apply
3) The MAQs are dependent on the floor level as follows:

At ground level, MAQs are 100% of the listed values
On 2nd floor, MAQs are 50% of the listed values
On 3rd floor, MAQs are 25% of the listed values
On 4th-6th floor, MAQs are 12.5% of the listed values
On 7th floor and above, MAQs are 5% of the listed values

Table D2. NFPA 45 *Standard on Fire Protection for Laboratories Using Chemicals* sets limits on the quantities of flammable and combustible liquids that can be stored in any one container based on the construction of the container. Aggregate quantities must still be below the amounts listed in Table D1.

Table D2. Maximum Allowable Size of Containers

	Flammable Liquids			***Combustible Liquids***	
	Class IA	Class IB	Class IC	Class II	Class III
Glass or approved plastic	1 pt.	1 qt.	1 gal.	1 gal.	1 gal.
Metal (other than DOT drums)	1 gal.	5 gal.	5 gal.	5 gal.	5 gal.
Safety cans	2 gal.	5 gal.	5 gal.	5 gal.	5 gal.
Metal drums (DOT specifications)	60 gal.	60 gal.	60 gal.	60 gal.	60 gal.
Approved portable tanks	660 gal.	660 gal.	660 gal.	660 gal.	660gal.

Table D3. The following chart lists the maximum volume of flammables and combustibles that can be stored in a single flammable storage cabinet. Again, quantities in a given control area cannot exceed MAQs listed above.

Table D3. Maximum Storage Quantities for a Flammable Storage Cabinet

MAXIMUM STORAGE QUANTITIES FOR CABINETS	
Liquid Class	***Maximum Storage Capacity***
Flammable/Class I	60 Gal.
Combustible/Class II	60 Gal.
Combustible/Class III	120 Gal.
Combination of classes	120 Gal.

Not more than 60 gallons may be Class I and Class II liquids. No more than 120 gallons of Class III liquids may be stored in a storage cabinet, according to OSHA 29 CFR 1910.106(d)(3) and NFPA 30 Section 4-3.1. **NOTE:** Not more than three such cabinets may be located in a single fire area, according to NFPA 30 Section 4-3.1.

Table D4. The IFC limits the quantities of flammable liquids that can be stored in a control area. The MAQs are based on the classification of the flammable liquids. The following table provides NFPA classification information for some common solvents. The NFPA fire diamond information is often found on containers or in SDSs. Liquids with a flammability rating of 3 are considered Class IB and IC liquids while those with a flammability rating of 4 are Class IA. **Note that Class IA, IB, and IC are flammable liquids. Class II liquids are combustible.**

Table D4. Flammable Liquid Storage, Properties and Classification

Chemical	Flash Point °F/ °C	Boiling Point	NFPA Classification
Acetic acid	103/39	245/118	II
Acetone	-4/-20	133/56	1B
Acetaldehyde	-38/-39	70/21	IA
Acetonitrile	42/6	179/82	IB
Acrylonitrile	32/0	171/77	IB
Benzene	12/-11	176/80	IB
t-Butyl Alcohol	52/11	181/83	IB
Cyclohexene	20/-7	181/83	IB
Dioxane	54/12	214/101	IB
Ethyl Acetate	24/-4	171/77	IB
Ethyl Alcohol	55/13	173/78	IB
Ethyl Ether	-49/-45	95/35	IA
Gasoline	-45/-43	100-400/38-204	IB
Hexane	-7/-22	156/69	IB
Isopropanol	53	183/83	IB
Methanol	52/11	174/64	IB
Methylene Chloride		104/40	-
Methyl Ethyl Ketone	16/-9	176/80	IB
Pentane	-40/	97/36	IA
Petroleum Ether	0/-18	95-140/35-60	IA-IB
Propyl Alcohol	74/23	207/97	IC
n-Propyl Ether	70/21	194/90	IB
Pyridine	68/20	239/115	IB
Tetrahydrofuran	6/-14	151/66	IB

Chemical	Flash Point °F/ °C	Boiling Point	NFPA Classification
Toluene	40/4	230/111	IB
Triethylamine	16/-7	193/89	IB
m-Xylene	77/25	282/38	IC

Table D5. The following table provides information on the hazards associated with common gases. This will aid risk assessments and also help determine MAQs. Since gases can fall into multiple categories (such as flammable and highly toxic) the most restrictive MAQ applies.

Table D5. Hazards of Common Gases

Gases	Asphyxiant	Flammable	Oxidizer	Corrosive	Toxic	Highly Toxic	Pyrophoric
Argon	X						
Ammonia (NH_3)		X		X	X		
Arsine (AsH_3)		X				X	
Boron Tribromide (BBr_3)				X	X		
Boron Trichloride (BCl_3)				X	X		
Bromine (Br_2)			X	X		X	
Carbon Dioxide	X						
Chlorine			X	X	X		
Chlorine Dioxide (ClO_2)			X		X		
Chlorine Trifluoride (ClF_3)			X		X		
Diborane (B_2H_6)		X				X	X
Dichlorosilane (SiH_2Cl_2)		X		X	X		
Ethylene Oxide (C_2H_4O)		X					
Fluorine (F_2)			X			X	
Helium	X						
Germane (GeH_4)		X			X		
Hydrogen	X	X					
Hydrogen Bromide (HBr)				X			
Hydrogen Chloride (HCl)				X			
Hydrogen Cyanide (HCN)		X				X	

Gases	Asphyxiant	Flammable	Oxidizer	Corrosive	Toxic	Highly Toxic	Pyrophoric
Hydrogen Fluoride (HF)				X	X		
Methyl Bromide (CH_3Br)		X			X		
Nickel Carbonyl [Ni $(CO)_4$]		X				X	
Nitrogen	X						
Nitrogen Dioxide			X		X		
Oxygen			X				
Phosgene						X	
Phosphine (PH_3)						X	X
Silane		X			X		X
Sulfur Dioxide (SO_2)				X			

DEFINITIONS:

COMBUSTIBLE LIQUID. A liquid having a closed cup flash point at or above 100°F (38°C). The category of combustible liquids does not include compressed gases or cryogenic fluids. Combustible liquids shall be subdivided as follows:
Class II. Liquids having a closed cup flash point at or above 100°F (38°C) and below 140°F (60°C).
Class IIIA. Liquids having a closed cup flash point at or above 140°F (60°C) and below 200°F (93°C).
Class IIIB. Liquids having a closed cup flash point at or above 200°F (93°C).

CONTROL AREA. Spaces within a building that are enclosed and bounded by exterior walls, fire walls, fire barriers and roofs, or a combination thereof, where quantities of hazardous materials not exceeding the maximum allowable quantities per control area are stored, dispensed, used or handled.

CORROSIVE. A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact. A chemical shall be considered corrosive if, when tested on the intact skin of albino rabbits by the method described in DOT 49 CFR, Part 173.137, such a chemical destroys or changes irreversibly the structure of the tissue at the point of contact following an exposure period of 4 hours. This term does not refer to action on inanimate surfaces. Highly acidic and basic compounds are typical examples of corrosive materials.

CRYOGENIC FLUID. A liquid having a boiling point lower than -150°F (-101°C) at atmospheric pressure.

FLAMMABLE LIQUID. A liquid having a closed cup flash point below 100°F (38°C). Flammable liquids are further categorized into a group known as Class I liquids. This category of flammable liquids does not include compressed gases or cryogenic fluids. The Class I category is subdivided as follows:
Class IA. Liquids having a flash point below 73°F (23°C) and a boiling point below 100°F (38°C).
Class IB. Liquids having a flash point below 73°F (23°C) and a boiling point at or above 100°F (38°C).
Class IC. Liquids having a flash point at or above 73°F (23°C) and below 100°F (38°C).

FLAMMABLE SOLID. A solid, other than a blasting agent or explosive, that is capable of causing fire through friction, absorption or moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which has an ignition temperature below 212°F (100°C) or which burns so vigorously and persistently when ignited as to create a serious hazard. A chemical shall be considered a flammable solid as determined in accordance with the test method of CPSC 16 CFR; Part 1500.44, if it ignites and burns with a self-sustained flame at a rate greater than 0.1 inch (2.5 mm) per second along its major axis.

FLASH POINT. The minimum temperature in degrees Fahrenheit at which a liquid will give off sufficient vapors to form an ignitable mixture with air near the surface or in the container, but will not sustain combustion. The flash point of a liquid shall be determined by appropriate test procedure and apparatus as specified in ASTM D 56, ASTM D 93 or ASTM D 3278.

HIGHLY TOXIC. A material which produces a lethal dose or lethal concentration that falls within any of the following categories:

1. A chemical that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Mixtures of these materials with ordinary materials, such as water, might not warrant classification as highly toxic. While this system is basically simple in application, any hazard evaluation that is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

ORGANIC PEROXIDE. An organic compound that contains the bivalent –O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by an organic radical. Organic peroxides can pose an explosion hazard (detonation or deflagration) or they can be shock sensitive. They can also decompose into various unstable compounds over an extended period of time.

> **Class I**. Those formulations that are capable of deflagration but not detonation.
>
> **Class II**. Those formulations that burn very rapidly and that pose a moderate reactivity hazard.
>
> **Class III**. Those formulations that burn rapidly and that pose a moderate reactivity hazard.
>
> **Class IV**. Those formulations that burn in the same manner as ordinary combustibles and that pose a minimal reactivity hazard.
>
> **Class V**. Those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that pose no reactivity hazard.
>
> **Unclassified detonable**. Organic peroxides that are capable of detonation. These peroxides pose an extremely high explosion hazard through rapid explosive decomposition.

OXIDIZER. A substance capable of oxidizing a reducing agent. Oxidizers are chemicals such as oxygen, chlorine, perchlorate and permanganates that support combustion but do not burn independently. Oxidizers can react violently with flammable and combustible materials. Oxidizers are subdivided as follows:

> **Class 4**. An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock. Additionally, the oxidizer will enhance the burning rate and can cause spontaneous ignition of combustibles.
>
> **Class 3**. An oxidizer that will cause a severe increase in the burning rate of combustible materials with which it comes in contact or that will undergo vigorous self-sustained decomposition due to contamination or exposure to heat.
>
> **Class 2**. An oxidizer that will cause a moderate increase in the burning rate or that causes spontaneous ignition of combustible materials with which it comes in contact.
>
> **Class 1**. An oxidizer whose primary hazard is that it slightly increases the burning rate but which does not cause spontaneous ignition when it comes in contact with combustible materials.

OXIDIZING GAS. A gas that can support and accelerate combustion of other materials.

PYROPHORIC. A chemical with an auto-ignition temperature in air, at or below a temperature of 130°F (54.4°C).

TOXIC. A chemical falling within any of the following categories:
A chemical that has a median lethal dose (LD_{50}) 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 (LD_{50}) 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 2 and 3 kilograms each.
A chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

UNSTABLE (REACTIVE) MATERIAL. A material, other than an explosive, which in the pure state or as commercially produced, will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including explosion, when exposed to heat, friction or shock, or in the absence of an inhibitor, or in the presence of contaminants, or in contact with incompatible materials. Unstable (reactive) materials are subdivided as follows:

> **Class 4**. Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. This class includes materials that are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.
>
> **Class 3**. Materials that in themselves are capable of detonation or of explosive decomposition or explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.
>
> **Class 2**. Materials that in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This class includes materials that can undergo chemical change with rapid release of energy

at normal temperatures and pressures, and that can undergo violent chemical change at elevated temperatures and pressures.

Class 1. Materials that in themselves are normally stable but which can become unstable at elevated temperatures and pressure.

WATER-REACTIVE MATERIAL. A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:

Class 3. Materials that react explosively with water without requiring heat or confinement.

Class 2. Materials that may form potentially explosive mixtures with water.

Class 1. Materials that may react with water with some release of energy, but not violently, include bromine, chlorine and fluorine.

Appendix E: EPCRA and DHS Laboratory Inventory Requirements

The College is subject to two key Federal regulations which require it to have knowledge of chemical inventories. The Emergency Planning and Community Right-to Know Act (EPCRA) requires the university to report quantities above specified thresholds for listed chemicals to state and local emergency planners. The Department of Homeland Security (DHS) also has created a list of Chemicals of Interest (COI) based on threat criteria such as sabotage, theft, and release. All chemical facilities in the U.S. must report any COIs maintained above the screening threshold quantities (STQs). There is also a Pennsylvania Right-to Know Act that specifies that all persons working in a laboratory shall have access to the names of chemicals in and around their immediate work area. In order to remain compliant the College requires that laboratory inventories of the specific chemicals (listed in the tables below) be maintained for federal regulations. Since most laboratories work with low quantities of material the lists have been truncated to include only those chemicals which have a low reporting threshold. All hazardous materials in a College laboratory shall be inventoried to comply with the PA Right-to Know Act. Chemical spills involving chemicals on the EPCRA list should be reported to College Safety Committee since specific reporting requirements may apply.

Table E1. EPCRA and CERCLA Reported Chemicals

Below is listed a subset of the EPCRA extremely hazardous substances list which have low threshold planning quantities (TPQs). A complete listing of these chemicals is located on the College website.

Chemical	CAS #	Density (lbs/gal)[1]	Threshold Planning Quantity (lbs)	Reportable Volume (gal)	Reportable Volume (L)
Nickel carbonyl	13463393	11.01	1	0.1	0.3
2-Chloro-N-(2-chloroethyl)-N-methylethanamine/ Mechlorethamine / Nitrogen mustard	51752	9.31	10	1.1	4.1
Carbonic dichloride / Phosgene	75445	11.43	10	0.9	3.3
Ethylene fluorohydrin	371620	9.20	10	1.1	4.1
Fluoroacetyl chloride	359068	11.27	10	0.9	3.4
Hydrogen selenide	7783075	Gas	10		
Lewisite	541253	15.73	10	0.6	2.4
Methyl vinyl ketone	78944	7.19	10	1.4	5.3
Phorate	298022	9.63	10	1.0	3.9
Propargyl bromide	106967	13.15	10	0.8	2.9
Sarin	107448	9.07	10	1.1	4.2
Tabun	77816	8.94	10	1.1	4.2
2-Propenoyl chloride / Acrylyl chloride	814686	9.28	100	10.8	40.8
Arsine	7784421	Gas	100		
Benzene, 1,3-diisocyanato-2-methyl- / Toluene-2,6-diisocyanate	91087	10.16	100	9.8	37.2
Benzoic trichloride / Benzotrichloride	98077	11.46	100	8.7	33.0
Bis(chloromethyl) ether / Chloromethyl ether / Dichloromethyl ether / Methane, oxybis[chloro-	542881	11.02	100	9.1	34.3
Chlorine	7782505	Gas	100		
Chloromethyl methyl ether / Methane, chloromethoxy-	107302	8.83	100	11.3	42.9
Cyanuric fluoride	675149	13.33	100	7.5	28.4
Diborane / Diborane(6)	19287457	Gas	100		
Dicrotophos	141662	10.13	100	9.9	37.4
Diisopropylfluorophosphate / Isofluorphate	55914	8.79	100	11.4	43.1
Diphosphoramide, octamethyl- / Schradan	152169	9.45	100	10.6	40.1
Formothion	2540821	11.34	100	8.8	33.4
Hexachlorocyclopentadiene	77474	14.18	100	7.1	26.7
Hydrocyanic acid / Hydrogen cyanide	74908	5.72 / Gas	100	17	66.2
Hydrofluoric acid / Hydrofluoric acid (conc. 50% or greater)	7664393	8.35	100	12.0	45.4

Hydrogen fluoride / Hydrogen fluoride (anhydrous)	7664393	Gas	100		
Iron carbonyl (Fe(CO)5), (TB-5-11)- / Iron, pentacarbonyl-	13463406	12.41	100	8.1	30.5
Lithium hydride	7580678	Solid	100		
Manganese, tricarbonyl methylcyclopentadienyl	12108133	11.58	100	8.6	32.7
Methacryloyl chloride	920467	9.06	100	11.0	41.8
Methacryloyloxyethyl isocyanate	30674807	9.15	100	10.9	41.4
Methyl phosphonic dichloride	676971	11.58	100	8.6	32.7
Nicotine / Pyridine, 3-(1-methyl-2-pyrrolidinyl)-,(S)-	54115	8.41	100	11.9	45.0
Nitric oxide / Nitrogen oxide (NO)	10102439	Gas	100		
Nitrogen dioxide	10102440	12.06 / Gas	100	8.3	31.4
Ozone	10028156	Gas	100		
Parathion / Phosphorothioic acid, O,O-diethyl-O-(4-nitrophenyl) ester	56382	10.50	100	9.5	36.7
Phosphamidon	13171216	10.11	100	9.9	37.5
Phosphonothioic acid, methyl-, S-(2-(bis(1-methylethyl)amino)ethyl) O-ethyl ester	50782699	8.40	100	11.9	45.1
Phosphorus / Phosphorus (yellow or white)	7723140	Solid	100		
Plumbane, tetramethyl- / Tetramethyllead	75741	16.62	100	6.0	22.8
Potassium cyanide	151508	Solid	100		
Sodium cyanide (Na(CN))	143339	Solid	100		
Sulfur fluoride (SF4), (T-4)- / Sulfur tetrafluoride	7783600	Gas	100		
Sulfur trioxide	7446119	Solid	100		
Tellurium hexafluoride	7783804	Gas	100		
TEPP / Tetraethyl pyrophosphate	107493	9.87	100	10.1	38.3
Terbufos	13071799	9.20	100	10.9	41.1
Tetraethyl lead	78002	13.77	100	7.3	27.5
Tetraethyltin	597648	9.99	100	10.0	37.9
Titanium chloride (TiCl4) (T-4)- / Titanium tetrachloride	7550450	14.38	100	7.0	26.3
Trichloro(chloromethyl)silane	1558254	12.30	100	8.1	30.8
Tris(2-chloroethyl)amine	555771	10.29	100	9.7	36.8

The Items with two threshold planning quantities listed (e.g., 1/10,000) are those where the lower TPQ number applies if the substance is present as a solid in powder form with particle size less than 100 microns, in solution or in molten form. Inventories must be maintained only when they are in the low TPQ form.

Chromic chloride	10025737	Solid	1/10,000[3]		
Emetine, dihydrochloride	316427	Solid	1/10,000		
4,6-Dinitro-o-cresol	534521	Solid	10/10,000		
Azinphos-methyl / Guthion	86500	Solid	10/10,000		
Benzenearsonic acid	98055	Solid	10/10,000		
Bis(chloromethyl) ketone	534076	Solid	10/10,000		
Carbofuran	1563662	Solid	10/10,000		
Cobalt carbonyl	10210681	Solid	10/10,000		
Colchicine	64868	Solid	10/10,000		
Digoxin	20830755	Solid	10/10,000		
Dimethyl-p-phenylenediamine	99989	Solid	10/10,000		
Dinitrocresol	534521	Solid	10/10,000		
Diphacinone	82666	Solid	10/10,000		
Endosulfan	115297	Solid	10/10,000		
Fenamiphos	22224926	Solid	10/10,000		
Fluoroacetic acid	144490	Solid	10/10,000		
Fluoroacetic acid, sodium salt	62748	Solid	10/10,000		
Monocrotophos	6923224	Solid	10/10,000		
Organorhodium Complex (PMN-82-147)	0	Solid	10/10,000		
Paraquat dichloride	1910425	Solid	10/10,000		
Paraquat methosulfate	2074502	Solid	10/10,000		
Sodium fluoroacetate	62748	Solid	10/10,000		

[1]Density (lb/gal) = specific gravity * 8.33

Table E2. DHS Chemical of Interest Reporting Requirements

Chemicals of Interest	Synonym	CAS Number	Min. Conc. (%)	STQs (in pounds unless otherwise noted)
Acetaldehyde		75-07-0	1	10,000
Acetone cyanohydrin, stabilized		75-86-5		
Acetyl bromide		506-96-7		
Acetyl chloride		75-36-5		
Acetyl iodide		507-02-8		
Acetylene	Ethyne	74-86-2	1	10,000
Acrolein	2-Propenal;Acrylaldehyde	107-02-8	1	5,000
Acrylonitrile	2-Propenenitrile	107-13-1	1	10,000
Acrylyl chloride	2-Propenoyl chloride	814-68-6	1	10,000
Allyl alcohol	2-Propen-1-ol	107-18-6	1	15,000
Allylamine	2-Propen-1-amine	107-11-9	1	10,000
Allyltrichlorosilane, stabilized		107-37-9		
Aluminum (powder)		7429-90-5		
Aluminum bromide, anhydrous		7727-15-3		
Aluminum chloride, anhydrous		7446-70-0		
Aluminum phosphide		20859-73-8		
Ammonia (anhydrous)		7664-41-7	1	10,000
Ammonia (conc. 20% or greater)		7664-41-7	20	20,000
Ammonium nitrate, [with more than 0.2 percent combustible substances, including any organic substance calculated as carbon, to the exclusion of any other added substance]		6484-52-2	ACG	5,000
Ammonium nitrate, solid [nitrogen concentration of 23% nitrogen or greater]		6484-52-2		
Ammonium perchlorate		7790-98-9	ACG	5,000
Ammonium picrate		131-74-8	ACG	5,000
Amyltrichlorosilane		107-72-2		
Antimony pentafluoride		7783-70-2		
Arsenic trichloride	Arsenous trichloride	7784-34-1	1	15,000
Arsine		7784-42-1	1	1,000
Barium azide		18810-58-7	ACG	5,000
1,4-Bis(2-chloroethylthio)-nbutane		142868-93-7		
Bis(2-chloroethylthio)methane		63869-13-6		
Bis(2-chloroethylthiomethyl)ether		63918-90-1		

1,5-Bis(2-chloroethylthio)-npentane		142868-94-8		
1,3-Bis(2-chloroethylthio)-npropane		63905-10-2		
Boron tribromide		10294-33-4		
Boron trichloride	Borane, trichloro	10294-34-5	1	5,000
Boron trifluoride	Borane, trifluoro	7637-07-2	1	5,000
Boron trifluoride compoundwith methyl ether (1:1)	Boron, trifluoro [oxybis (methane), T-4	353-42-4	1	15,000
Bromine		7726-95-6	1	10,000
Bromine chloride		13863-41-7		
Bromine pentafluoride		7789-30-2		
Bromine trifluoride		7787-71-5		
Bromotrifluorethylene	Ethene, bromotrifluoro-	598-73-2	1	10,000
1,3-Butadiene		106-99-0	1	10,000
Butane		106-97-8	1	10,000
Butene		25167-67-3	1	10,000
1-Butene		106-98-9	1	10,000
2-Butene		107-01-7	1	10,000
2-Butene-cis		590-18-1	1	10,000
2-Butene-trans	2-Butene, (E)	624-64-6	1	10,000
Butyltrichlorosilane		7521-80-4		
Calcium hydrosulfite	Calcium dithionite	15512-36-4		
Calcium phosphide		1305-99-3		
Carbon disulfide		75-15-0	1	20,000
Carbon oxysulfide	Carbon oxide sulfide (COS);carbonyl sulfide	463-58-1	1	10,000
Carbonyl fluoride		353-50-4		
Carbonyl sulfide		463-58-1		
Chlorine		7782-50-5	1	2,500
Chlorine dioxide	Chlorine oxide, (ClO2)	10049-04-4	1	1,000
Chlorine monoxide	Chlorine oxide	7791-21-1	1	10,000
Chlorine pentafluoride		13637-63-3		
Chlorine trifluoride		7790-91-2		
Chloroacetyl chloride		79-04-9		
2-Chloroethylchloromethylsulfide		2625-76-5		
Chloroform	Methane, trichloro-	67-66-3	1	20,000
Chloromethyl ether	Methane, oxybis(chloro-)	542-88-1	1	1,000
Chloromethyl methyl ether	Methane, chloromethoxy-	107-30-2	1	5,000
1-Chloropropylene	1-Propene, 1-chloro-	590-21-6	1	10,000
2-Chloropropylene	1-Propene, 2-chloro-	557-98-2	1	10,000
Chlorosarin	o-Isopropyl methylphosphonochloridate	1445-76-7		

Chlorosoman	o-Pinacolyl methylphosphonochloridate	7040-57-5		
Chlorosulfonic acid		7790-94-5		
Chromium oxychloride		14977-61-8		
Crotonaldehyde	2-Butenal	4170-30-3	1	10,000
Crotonaldehyde, (E)-	2-Butenal, (E)-	123-73-9	1	10,000
Cyanogen	Ethanedinitrile	460-19-5	1	10,000
Cyanogen chloride		506-77-4	1	10,000
Cyclohexylamine	Cyclohexanamine	108-91-8	1	15,000
Cyclohexyltrichlorosilane		98-12-4		
Cyclopropane		75-19-4	1	10,000
DF	Methyl phosphonyl difluoride	676-99-3		
Diazodinitrophenol		87-31-0	ACG	5,000
Diborane		19287-45-7	1	2,500
Dichlorosilane	Silane, dichloro-	4109-96-0	1	10,000
N,N-(2-diethylamino)ethanethiol		100-38-9		
Diethyldichlorosilane		1719-53-5		
o,o-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate		78-53-5		
Diethyleneglycol dinitrate		693-21-0	ACG	5,000
Diethyl methylphosphonite		15715-41-0		
N,N-Diethyl phosphoramidic dichloride		1498-54-0		
N,N-(2-diisopropylamino)ethanethiol N,N-diisopropyl-(beta)-aminoethane thiol		5842-07-9		
Difluoroethane	Ethane, 1,1-difluoro-	75-37-6	1	10,000
N,N-Diisopropyl phosphoramidic dichloride		23306-80-1		
1,1-Dimethylhydrazine	Hydrazine, 1, 1-dimethyl-	57-14-7	1	10,000
Dimethylamine	Methanamine, N-methyl-	124-40-3	1	10,000
N,N-(2-dimethylamino)ethanethiol		108-02-1		
Dimethyldichlorosilane	Silane, dichlorodimethyl-	75-78-5	1	10,000
N,N-Dimethyl phosphoramidic dichloride Dimethylphosphoramidodichloridate		677-43-0		
2,2-Dimethylpropane	Propane, 2,2-dimethyl-	463-82-1	1	10,000
Dingu	Dinitroglycoluril	55510-04-8	ACG	5,000
Dinitrogen tetroxide		10544-72-6		
Dinitrophenol		25550-58-7	ACG	5,000
Dinitroresorcinol		519-44-8	ACG	5,000
Diphenyldichlorosilane		80-10-4		

Dipicryl sulfide		2217-06-3	ACG	5,000
Dipicrylamine [or] Hexyl	Hexanitrodiphenylamine	131-73-7	ACG	5,000
N,N-(2-dipropylamino)ethanethiol		5842-06-8		
N,N-Dipropyl phosphoramidic dichloride		40881-98-9		
Dodecyltrichlorosilane		4484-72-4		
Epichlorohydrin	Oxirane, (chloromethyl)-	106-89-8	1	20,000
Ethane		74-84-0	1	10,000
Ethyl acetylene	1-Butyne	107-00-6	1	10,000
Ethyl chloride	Ethane, chloro-	75-00-3	1	10,000
Ethyl ether	Ethane, 1,1-oxybis-	60-29-7	1	10,000
Ethyl mercaptan	Ethanethiol	75-08-1	1	10,000
Ethyl nitrite	Nitrous acid, ethyl ester	109-95-5	1	10,000
Ethyl phosphonyl difluoride		753-98-0		
Ethylamine	Ethanamine	75-04-7	1	10,000
Ethyldiethanolamine		139-87-7		
Ethylene	Ethene	74-85-1	1	10,000
Ethylene oxide	Oxirane	75-21-8	1	10,000
Ethylenediamine	1,2-Ethanediamine	107-15-3	1	20,000
Ethyleneimine	Aziridine	151-56-4	1	10,000
Ethylphosphonothioic dichloride		993-43-1		
Ethyltrichlorosilane		115-21-9		
Fluorine		7782-41-4	1	1,000
Fluorosulfonic acid		7789-21-1		
Formaldehyde (solution)		50-00-0	1	15,000
Furan		110-00-9	1	10,000
Germane		7782-65-2		
Germanium tetrafluoride		7783-58-6		
Guanyl nitrosaminoguanylidene hydrazine			ACG	5,000
Hexaethyl tetraphosphate and compressed gas mixtures		757-58-4		
Hexafluoroacetone		684-16-2		
Hexanitrostilbene		20062-22-0	ACG	5,000
Hexolite	Hexotol	121-82-4	ACG	5,000
Hexyltrichlorosilane		928-65-4		
HMX	Cyclotetramethylenetetranitramine	2691-41-0	ACG	5,000
HN1 (nitrogen mustard-1)	Bis(2-chloroethyl)ethylamine	538-07-8		
HN2 (nitrogen mustard-2)	Bis(2-chloroethyl)methylamine	51-75-2		
HN3 (nitrogen mustard-3)	Tris(2-chloroethyl)amine	555-77-1		

Hydrazine		302-01-2	1	10,000
Hydrochloric acid (conc. 37% or greater)		7647-01-0	37	15,000
Hydrocyanic acid		74-90-8	1	2,500
Hydrofluoric acid (conc. 50% or greater)		7664-39-3	50	1,000
Hydrogen		1333-74-0	1	10,000
Hydrogen bromide (anhydrous)		10035-10-6		
Hydrogen chloride (anhydrous)		7647-01-0	1	5,000
Hydrogen cyanide	Hydrocyanic acid	74-90-8		
Hydrogen fluoride (anhydrous)		7664-39-3	1	1,000
Hydrogen iodide, anhydrous		10034-85-2		
Hydrogen peroxide (concentration of at least 35%)		7722-84-1		
Hydrogen selenide		7783-07-5	1	10,000
Hydrogen sulfide		7783-06-4	1	10,000
Iodine pentafluoride		7783-66-6		
Iron, pentacarbonyl-	Iron carbonyl (Fe (CO)5), (TB5-11)-	13463-40-6	1	10,000
Isobutane	Propane, 2-methyl	75-28-5	1	10,000
Isobutyronitrile	Propanenitrile, 2-methyl-	78-82-0	1	20,000
Isopentane	Butane, 2-methyl-	78-78-4	1	10,000
Isoprene	1,3-Butadiene, 2-methyl-	78-79-5	1	10,000
Isopropyl chloride	Propane, 2-chloro-	75-29-6	1	10,000
Isopropyl chloroformate	Carbonochloridic acid, 1-methylethyl ester	108-23-6	1	15,000
Isopropylamine	2-Propanamine	75-31-0	1	10,000
Isopropylphosphonothioic dichloride		1498-60-8		
Isopropylphosphonyl difluoride		677-42-9		
Lead azide		13424-46-9	ACG	5,000
Lead styphnate	Lead trinitroresorcinate	15245-44-0	ACG	5,000
Lewisite 1	2-Chlorovinyldichloroarsine	541-25-3		
Lewisite 2	Bis(2-chlorovinyl)chloroarsine	40334-69-8		
Lewisite 3	Tris(2-chlorovinyl)arsine	40334-70-1		
Lithium amide		7782-89-0		
Lithium nitride		26134-62-3		
Magnesium (powder)		7439-95-4		
Magnesium diamide		7803-54-5		
Magnesium phosphide		12057-74-8		
MDEA	Methyldiethanolamine	105-59-9		
Mercury fulminate		628-86-4	ACG	5,000

Methacrylonitrile	2-Propenenitrile, 2-methyl-	126-98-7	1	10,000
Methane		74-82-8	1	10,000
2-Methyl-1-butene		563-46-2	1	10,000
3-Methyl-1-butene		563-45-1	1	10,000
Methyl chloride	Methane, chloro-	74-87-3	1	10,000
Methyl chloroformate	Carbonochloridic acid, methyl ester	79-22-1	1	10,000
Methyl ether	Methane, oxybis-	115-10-6	1	10,000
Methyl formate	Formic acid Methyl ester	107-31-3	1	10,000
Methyl hydrazine	Hydrazine, methyl-	60-34-4	1	15,000
Methyl isocyanate	Methane, isocyanato-	624-83-9	1	10,000
Methyl mercaptan	Methanethiol	74-93-1	1	10,000
Methyl thiocyanate	Thiocyanic acid, methyl ester	556-64-9	1	20,000
Methylamine	Methanamine	74-89-5	1	10,000
Methylchlorosilane		993-00-0		
Methyldichlorosilane		75-54-7		
Methylphenyldichlorosilane		149-74-6		
Methylphosphonothioic dichloride		676-98-2		
2-Methylpropene	1-Propene, 2-methyl-	115-11-7	1	10,000
Methyltrichlorosilane	Silane, trichloromethyl-	75-79-6	1	10,000
Sulfur mustard (Mustard gas(H))	Bis(2-chloroethyl)sulfide	505-60-2		
O-Mustard (T)	Bis(2-chloroethylthioethyl)ether	63918-89-8		
Nickel Carbonyl		13463-39-3	1	10,000
Nitric acid		7697-37-2	80	15,000
Nitric oxide	Nitrogen oxide (NO)	10102-43-9	1	10,000
Nitrobenzene		98-95-3		
5-Nitrobenzotriazol		2338-12-7	ACG	5,000
Nitrocellulose		9004-70-0	ACG	5,000
Nitrogen mustard hydrochloride	Bis(2-chloroethyl)methylamine hydrochloride	55-86-7		
Nitrogen trioxide		10544-73-7		
Nitroglycerine		55-63-0	ACG	5,000
Nitromannite	Mannitol hexanitrate, wetted	15825-70-4	ACG	5,000
Nitromethane		75-52-5		
Nitrostarch		9056-38-6	ACG	5,000
Nitrosyl chloride		2696-92-6		
Nitrotriazolone		932-64-9	ACG	5,000
Nonyltrichlorosilane		5283-67-0		
Octadecyltrichlorosilane		112-04-9		

Octolite		57607-37-1	ACG	5,000
Octonal		78413-87-3	ACG	5,000
Octyltrichlorosilane		5283-66-9		
Oleum (Fuming Sulfuric acid)	Sulfuric acid, mixture with sulfur trioxide	8014-95-7	1	10,000
Oxygen difluoride		7783-41-7		
1,3-Pentadiene		504-60-9	1	10,000
Pentane		109-66-0	1	10,000
1- Pentene		109-67-1	1	10,000
2-Pentene, (E)-		646-04-8	1	10,000
2-Pentene, (Z)-		627-20-3	1	10,000
Pentolite		8066-33-9	ACG	5,000
Peracetic acid	Ethaneperoxic acid	79-21-0	1	10,000
Perchloromethylmercaptan	Meth anesulfenyl chloride, trichloro-	594-42-3	1	10,000
Perchloryl fluoride		7616-94-6		
PETN	Pentaerythritol tetranitrate	78-11-5	ACG	5,000
Phenyltrichlorosilane		98-13-5		
Phosgene	Carbonic dichloride;carbonyl dichloride	75-44-5	1	500
Phosphine		7803-51-2	1	10,000
Phosphorus		7723-14-0		
Phosphorus oxychloride	Phosphoryl chloride	10025-87-3	1	5,000
Phosphorus pentabromide		7789-69-7		
Phosphorus pentachloride		10026-13-8		
Phosphorus pentasulfide		1314-80-3		
Phosphorus trichloride		7719-12-2	1	15,000
Picrite	Nitroguanidine	556-88-7	ACG	5,000
Piperidine		110-89-4	1	10,000
Potassium chlorate		3811-04-9		
Potassium cyanide		151-50-8		
Potassium nitrate		7757-79-1		
Potassium perchlorate		7778-74-7		
Potassium permanganate		7722-64-7		
Potassium phosphide		20770-41-6		
Propadiene	1,2-Propadiene	463-49-0	1	10,000
Propane		74-98-6	1	60,000
Propionitrile	Propanenitrile	107-12-0	1	10,000
Propyl chloroformate	Carbonchloridic acid, propylester	109-61-5	1	10,000
Propylene [1-Propene]		115-07-1	1	10,000
Propylene oxide	Oxirane, methyl-	75-56-9	1	10,000

Propyleneimine	Aziridine, 2-methyl-	75-55-8	1	10,000
Propylphosphonothioic dichloride		2524-01-8		
Propylphosphonyl difluoride		690-14-2		
Propyltrichlorosilane		141-57-1		
Propyne	1-Propyne	74-99-7	1	10,000
QL	o-Ethyl-o-2-diisopropylaminoethyl methylphosphonite	57856-11-8		
RDX	Cyclotrimethylenetrinitramine	121-82-4	ACG	5,000
RDX and HMX mixtures		121-82-4	ACG	5,000
Sarin	o-Isopropylmethylphosphonofluoridate	107-44-8		
Selenium hexafluoride		7783-79-1		
Sesquimustard	1,2-Bis(2-chloroethylthio)ethane	3563-36-8		
Silane		7803-62-5	1	10,000
Silicon tetrachloride		10026-04-7		
Silicon tetrafluoride		7783-61-1		
Sodium azide		26628-22-8		
Sodium chlorate		7775-09-9		
Sodium cyanide		143-33-9		
Sodium hydrosulfite	Sodium dithionite	7775-14-6		
Sodium nitrate		7631-99-4		
Sodium phosphide		12058-85-4		
Soman	o-Pinacolyl methylphosphonofluoridate	96-64-0		
Stibine		7803-52-3		
Strontium phosphide		12504-16-4		
Sulfur dioxide (anhydrous)		7446-09-5	1	5,000
Sulfur tetrafluoride	Sulfur fluoride (SF4), (T-4)-	7783-60-0	1	2,500
Sulfur trioxide		7446-11-9	1	10,000
Sulfuryl chloride		7791-25-5		
Tabun	o-Ethyl-N,Ndimethylphosphoramido-cyanidate	77-81-6		
Tellurium hexafluoride		7783-80-4		
Tetrafluoroethylene	Ethene, tetrafluoro-	116-14-3	1	10,000
Tetramethyllead	Plumbane, tetramethyl-	75-74-1	1	10,000
Tetramethylsilane	Silane, tetramethyl-	75-76-3	1	10,000
Tetranitroaniline		53014-37-2	ACG	5,000
Tetranitromethane	Methane, tetranitro-	509-14-8	1	10,000
Tetrazene	Guanyl nitrosaminoguanyltetrazene	109-27-3	ACG	5,000
1H-Tetrazole		288-94-8	ACG	5,000

Thiodiglycol	Bis(2-hydroxyethyl)sulfide	111-48-8		
Thionyl chloride		7719-09-7		
Titanium tetrachloride	Titanium chloride (TiCl4) (T-4)-	7550-45-0	1	2,500
TNT	Trinitrotoluene	118-96-7	ACG	5,000
Torpex	Hexotonal	67713-16-0	ACG	5,000
Trichlorosilane	Silane, trichloro-	10025-78-2	1	10,000
Triethanolamine		102-71-6		
Triethanolamine hydrochloride		637-39-8		
Triethyl phosphate		122-52-1		
Trifluoroacetyl chloride		354-32-5		
Trifluorochloroethylene	Ethene, chlorotrifluoro	79-38-9	1	10,000
Trimethylamine	Meth anamine, N,N-dimethyl-	75-50-3	1	10,000
Trimethylchlorosilane	Silane, chlorotrimethyl-	75-77-4	1	10,000
Trimethyl phosphate		121-45-9		
Trinitroaniline		26952-42-1	ACG	5,000
Trinitroanisole		606-35-9	ACG	5,000
Trinitrobenzene		99-35-4	ACG	5,000
Trinitrobenzenesulfonic acid		2508-19-2	ACG	5,000
Trinitrobenzoic acid		129-66-8	ACG	5,000
Trinitrochlorobenzene		88-88-0	ACG	5,000
Trinitrofluorenone		129-79-3	ACG	5,000
Trinitro-meta-cresol		602-99-3	ACG	5,000
Trinitronaphthalene		55810-17-8	ACG	5,000
Trinitrophenetole		4732-14-3	ACG	5,000
Trinitrophenol		88-89-1	ACG	5,000
Trinitroresorcinol		82-71-3	ACG	5,000
Tritonal		54413-15-9	ACG	5,000
Tungsten hexafluoride		7783-82-6		
Vinyl acetate monomer	Acetic acid ethenyl ester	108-05-4	1	10,000
Vinyl acetylene	1-Buten-3-yne	689-97-4	1	10,000
Vinyl chloride	Ethene, chloro-	75-01-4	1	10,000
Vinyl ethyl ether	Ethene, ethoxy-	109-92-2	1	10,000
Vinyl fluoride	Ethene, fluoro-	75-02-5	1	10,000
Vinyl methyl ether	Ethene, methoxy-	107-25-5	1	10,000
Vinylidene chloride	Ethene, 1,1-dichloro-	75-35-4	1	10,000
Vinylidene fluoride	Ethene, 1,1-difluoro-	75-38-7	1	10,000
Vinyltrichlorosilane		75-94-5		
VX	o-Ethyl-S-2-diisopropylaminoethyl methyl phosphonothiolate	50782-69-9		
Zinc hydrosulfite	Zinc dithionite	7779-86-4		

Appendix F: College of Natural Science and Mathematics Forms and Signs

Form / Sign Name	Form / Sign Number
Used Chemical Waste Label	CNSM 2013-01
CNSM Injury Report Form	CNSM 2013-02
CNSM Student Safety Training Form	CNSM 2013-03
CNSM Laboratory Inspection Checklist	CNSM 2013-04
CNSM Chemical Refrigerator Emergency Information (Version 1)	CNSM 2013-05v1
CNSM Chemical Refrigerator Emergency Information (Version 2)	CNSM 2013-05v2
CNSM Chemical Refrigerator Emergency Information (Version 3)	CNSM 2013-05v3
CNSM Domestic Refrigerator Sign	CNSM 2013-06
CNSM Explosion Proof Refrigerator Sign	CNSM 2013-07
CNSM Ice Machine Sign	CNSM 2013-08
CNSM Food Only Sign	CNSM 2013-09
CNSM Research Student Orientation Checklist Form	CNSM 2013-10
Laboratory Personnel	CNSM 2013-11