Tab #	**Title**	**Description**	**Action Required**
1	Introduction	Introduces the OSHA Lab standard and the scope of the CHP	
2	Responsibility / Emergency Contacts	Identification of responsible person and contact information in the event of an emergency.	
3	Lab safety Agreement	Provides agreement form.	Each worker must sign the agreement. Keep copies here.
4	Hazard Identification and Assessment		
5	Lab Specific Standard Operating Procedures		
6	Lab Safety Practices		
7	Hazard Communication		
8	Hazardous Waste and Spills		
9	Accidents / Injuries in the Lab		
10	Chemical Storage		
11	Fume Hoods		
12	Training Documentation		

APSU Chemical Hygiene Plan Section 1:

INTRODUCTION

Austin Peay State University recognizes its obligation to provide a program for health, safety and environmental compliance and to minimize health hazards and risk of injury. This Chemical Hygiene Plan serves to protect students and employees from potential health and safety hazards associated with the handling, use, and storage of hazardous chemicals in laboratories while meeting the requirements of the Tennessee and Federal OSHA Laboratory Standard, 29 CFR 1910.1450.

SCOPE AND APPLICATION

The purpose of this Chemical Hygiene Plan (CHP) is to provide guidance to laboratory staff regarding the safe use of chemicals and to ensure compliance with federal regulations. This plan will be made site specific for each lab operating and using chemicals on the APSU campus. Each individual lab must perform a Hazard Assessment of the storage, use, and disposal of lab chemicals.

The CHP must be readily available to all employees working in a lab as well as regulatory officials. This core guidance document will be reviewed and updated annually by EHS management. Lab faculty and staff shall review and update site specific plans annually as well. All reviews must be recorded on the cover page along with the signature of the PI, Lab Manager, or Department Chair.

Why is having a CHP important?

1. It makes the lab a safer place. This plan has been prepared to outline the institutional policies and lab-specific procedures required for the safe handling of hazardous chemicals.
2. ***It is required by law*** as set out in OSHA regulations. These regulations state that each employer covered by the regulation should have a thorough and accessible plan to follow to keep lab workers safe. It also describes what each section of the CHP must include.
3. The Environmental Affairs Committee will be checking your CHP as part of routine laboratory safety inspections.

How do I use this plan?

1. Require all lab workers to read this plan in its entirety.
2. Require all lab workers to sign the lab agreement showing that they have read and will adhere to safe working procedures for your laboratory.

3. Use the following list to conduct an annual safety check:
    - Review the CHP and ensure that it accurately reflects lab activities. If new hazards are present, safety protocols should be updated to reflect the lab-specific sections. Document the date that the CHP was reviewed on the cover page.
    - Assure that new personnel first receive training on the CHP and sign the lab safety agreement.
    - Verify that door signage and personnel contact information are current and accurate.
    - Update the chemical inventory.

- Evaluate lab safety using the Lab safety Inspection Checklist available on the APSU EHS website, www.apsu.edu/health-safety

APSU Chemical Hygiene Plan Section 2:

RESPONSIBILITY / EMERGENCY CONTACTS

Each department must identify a **Lab Safety Representative (LSR**). The LSR will provide technical guidance to the department and oversee the development of lab-specific standard operating procedures (SOPs). The LSR will also ensure that the annual audits are completed.

The **Principal Investigator (PI) or Lab Manager** has the responsibility for managing hazards in his/her laboratory. Hazard management includes the following:

- Completing a chemical inventory, annually
- Completing a hazard assessment for each procedure
- Instructing laboratory personnel on potential hazards
- Training employees on the CHP
- Correcting dangerous behaviors and conditions
- Encouraging a positive attitude toward safety
- Selecting appropriate PPE and ensuring it is worn by lab personnel

Individual workers are responsible for their own safety and the safety of their co-workers and students in their laboratories. All staff must demonstrate a commitment to safe work practices by their actions and attitudes. They must wear the appropriate personal protective equipment (PPE), ensure that hazards are minimized, adhere to the pertinent safety rules and regulations, and know the applicable contents of the CHP. They must also sign the Lab Safety Agreement.

The University **Chemical Hygiene Officer (CHO)** has primary responsibility for ensuring the implementation of TOSHA regulation "Occupational Exposure to Hazardous Chemicals in Laboratories," 29 CFR 1910.1450.

The CHO is a member of EH&S and, with support from other EH&S personnel, is responsible for:

- Informing Faculty/Laboratory Supervisors of chemical-related health and safety requirements and assisting with the selection of appropriate safety controls, including engineering controls, laboratory and other workplace practices and procedures, training, and personal protective equipment;
- Helping to develop and implement appropriate chemical hygiene policies and practices;
- Working with Departments and lab groups to develop and review SOPs for processes using hazardous chemicals;
- Conducting periodic inspections and immediately taking steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
- Performing hazard assessments, upon request; and
- At least annually, reviewing and evaluating the effectiveness of the Laboratory Safety Manual and making updates as appropriate.

Department: _____

Lab Identification (Building and Room Number): _____

Laboratory Safety Representative: _____

Principal Investigator / Lab Manager /

Other Responsible Party (Please Print):_____

In the event of an emergency in the lab (e.g. chemical spill, fire, flooding), the following person will have knowledge of the chemicals being used in this lab, potential hazards, and other pertinent lab knowledge.

Emergency Contact (Please Print): _____

On-Campus Office and Phone Number: _____

After Hours Phone Number: _____

EH&S After Hours Phone Number: Carl Gerhold 615-803-0366

APSU Chemical Hygiene Plan Section 3:

LAB SAFETY AGREEMENT

The lab safety agreement is a contract between the lab worker and the university, which requires the worker to follow all standard and special safety requirements in the lab. The lab worker must be familiar with safe lab practices and emergency procedures, including emergency contact information.

Signed copies of the agreement must be maintained in this binder for each lab worker.

APSU Lab Safety Agreement

- ☐ I know the location of the Chemical Hygiene Plan (CHP) and the information it contains. The CHP is located _____.
- ☐ I know how to retrieve Safety Data Sheets (SDS) and how to use the information provided in Safety Data Sheets.
- ☐ I know the location of the nearest eyewash and safety shower and how to operate them, if needed. The nearest safety shower is _____. The nearest eyewash is _____.
- ☐ I know the location of the chemical or biological spill kit and how to use the kit contents. The spill kit is located_____.
- ☐ I know the lab's emergency procedures in case of a fire.
- ☐ I know where the closest fire extinguisher is located and how to operate it.
- ☐ I know where our lab/department meets in case of an evacuation. Our assembly point is _____.
- ☐ I know the emergency contact phone numbers for this lab and when to use them. These numbers are located _____.
- ☐ I know the safety equipment available in this lab and when it should be used (e.g. gloves, goggles, lab coats). I always wear eye protection when _____.

The APSU Environmental Health and Safety Assistant Director is Carl Gerhold, 6103, gerholdc@apsu.edu

I _____ (Lab User's Name) have read and fully understand the laboratory procedures and agree to follow them during all laboratory activities.

_____ _____

(Signature) (Date)

Supervisor Authorization:_____ Date:_____

APSU Chemical Hygiene Plan Section 4:

HAZARD IDENTIFICATION AND ASSESSMENT

All chemicals have inherent properties (physical, chemical, toxicological, etc.) that may be dangerous to personnel working with those substances. It is imperative that laboratory personnel understand the hazards associated with the materials being used in their lab. The typical hazards encountered in a university laboratory setting include the following:

4.1 General Classes of Hazardous Chemicals

- Flammability
- Corrosivity
- Reactivity (including explosivity)
- Toxicity (including irritation, carcinogenicity, reproductive toxicity, etc.)
- Compressed Gases
- Biological Hazards
- Radioactive Materials

4.1.1 Flammable and Combustible Liquids

Flammable and combustible liquids are classified according to their flash point. Flammable liquids have a flash point less than 100°F and combustible liquids have a flash point between 100-200°F. Both flammable and combustible liquids are considered fire hazards. *See Lab Specific Standard Operating Procedures for a General Use SOP for Flammable and Combustible Liquids.

4.1.2 Corrosive Materials

Corrosive materials cause destruction of tissue through chemical action at the point of contact. Corrosive chemicals can be liquids, solids, or gases, and can affect the skin, eyes, and respiratory tract. Examples of corrosive chemicals include sodium hydroxide, hydrochloric acid, and phenol. *See Lab Specific Standard Operating Procedures for a General Use SOP for Corrosives.

4.1.3 Highly Reactive / Unstable Materials

Highly reactive or unstable materials are those that have the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, temperature, light, or contact with another material. Examples of highly reactive chemicals are peroxides, water-reactives, and pyrophorics. *See Lab Specific Standard Operating Procedures for a General Use SOP for Highly Reactive Materials.

4.1.4 Compressed Gases

Compressed gases can create pressure hazards and can also create health hazardous and/or flammable atmospheres. One special property of compressed gases is that they undergo substantial volume expansion when released to air, potentially depleting workplace oxygen content to hazardous levels. *See Lab Specific Standard Operating Procedures for a General Use SOP for Compressed Gases.

4.1.5 Carcinogens

Carcinogens are chemicals or physical agents that cause cancer or tumor development, typically after repeated or chronic exposure. Their effects may only become evident after a long latency period and may cause no immediate harmful effects. *See Lab Specific Standard Operating Procedures for a General Use SOP for Carcinogens.

4.1.6 Reproductive Toxins

Reproductive toxins include substances that cause chromosomal damage (mutations) or lethal or malformation effects on fetuses (teratogensis). Many reproductive toxins cause damage after repeated low-level exposures. Effects become evident after long latency periods. * See Lab Specific Standard Operating Procedures for a General Use SOP for Reproductive Toxins.

4.1.7 Highly Toxic Chemicals

Chemicals with a high level of acute toxicity have the ability to cause harmful local and systemic effects after a single exposure. Many of these chemicals may also be characterized as a toxic gas, CDC Select Agent Toxin, corrosive, irritant or sensitizer. *See Lab Specific Standard Operating Procedures for a General Use SOP for Highly Toxic Chemicals.

4.1.8 Sensitizers

A sensitizer is a substance that causes exposed people to develop an allergic reaction in normal tissue after repeated exposure to the substance. Examples of sensitizers used in laboratories include formaldehyde, many phenol derivatives, and latex proteins (commonly found in latex lab gloves). *See Lab Specific Standard Operating Procedures for a General Use SOP for Sensitizers.

4.1.9 Irritants

Irritants are chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds are irritants; thus, skin contact with all laboratory chemicals should be avoided. *See Lab Specific Standard Operating Procedures for a General Use SOP for Irritants.

4.2 Minimizing Exposures to Hazardous Chemicals

4.2.1 Engineering Controls:

As general lab ventilation cannot be relied upon to protect personnel from localized exposures to hazardous levels of airborne chemicals, engineering controls such as laboratory fume hoods and other local exhaust systems (e.g., drop down flexible snorkels) are often necessary to provide additional exposure control. In general, laboratory fume hoods are recommended whenever using hazardous chemicals that:

- Have high acute toxicity, or which are carcinogens, or reproductive toxins except where there is very low risk of exposures (e.g., use of minimal quantities in a closed system).
- Have a permissible exposure limit (found on SDS) of less than 50 ppm (or 0.25 mg/m3 for particulate matter).
- Are appreciably volatile (e.g. solvents) or are easily dispersible in air (e.g. dust).
  *See Section 11, *Fume Hoods,* for information on appropriate use of fume hoods.

4.2.2 Administrative Controls

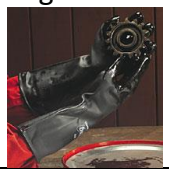
Administrative controls for minimizing exposures to hazardous chemicals include the following:

- Substituting in less hazardous chemicals (e.g. using proprietary detergents instead of chromic acid for cleaning glassware; or, using toluene instead of benzene for liquid-liquid extraction or chromatography). Isolating or enclosing an experiment within a closed system (i.e. glove box, sealed chamber). Micro scaling the size of the experiment to reduce the amount of chemical usage.

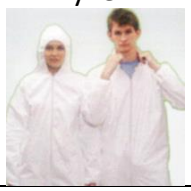
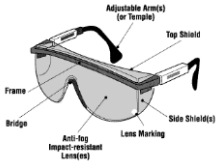
4.2.3 Personal Protective Equipment

In addition to both engineering and administrative exposure controls, personal protective equipment (PPE) may be necessary to ensure an adequate margin of safety in case of incidental/accidental chemical release or contact.

The chart below can assist laboratory personnel in the selection of appropriate PPE.

PPE	Specific Type	Characteristics	Applications
Light latex, vinyl or nitrile gloves	Disposable Latex Gloves 	Powdered or un-powdered	Working with biological hazards (known or potentially known infectious materials including work with animals)
	Disposable nitrile gloves 	Puncture, abrasion resistant, protection from splash hazards	Working with biological hazards and chemical splash hazards
	Disposable vinyl gloves 	Economical, durable, similar to latex	Working with biological hazards
Light chemical resistant gloves	Natural rubber latex 	Chemical resistant, liquid-proof	Working with small volumes of corrosive liquids, organic solvents, flammable organic compounds
Light to heavy chemical resistant gloves	Nitrile gloves 	Chemical resistant, good puncture, cut, and abrasion resistance	Apparatus under pressure, air or water reactive chemicals
PPE	Specific Type	Characteristics	Applications
Heavy chemical resistant gloves	Butyl gloves 	High permeation resistance to most chemicals	Large volumes of organic solvents, small to large volumes of dangerous solvents, acutely toxic or hazardous materials
	Viton II gloves 	High permeation resistance to most chemicals	Same as butyl gloves, plus hazardous material spills
	Butyl/Silver Shield gloves and apron 	Extra chemical and mechanical protection	Same as butyl and Viton II gloves, added mechanical protection, hazardous material spills

Insulated gloves	Terrycloth autoclave gloves 	Heat resistant	Working with hot liquids and equipment, open flames, water bath, oil bath
	Cryogen gloves 	Water resistant or water proof, protection against ultra-cold temperatures	Cryogenic liquids handling
Wire mesh gloves		Cut resistant	Working with live animals
Chemical resistant apron	Rubber-coated wash apron 	Chemical splash protection, good abrasion resistance	Working with apparatus under pressure, air or water reactive chemicals, large volumes of corrosive liquids
	Neoprene apron and sleeves 	Chemical resistant, tear resistant; splash protection	Water or air reactive chemicals, large volumes of corrosive liquids, small to large volumes of acutely toxic corrosives
PPE	Specific Type	Characteristics	Applications
Lab Coats	Knee length 	Protects skin and clothing from dirt, inks, non-hazardous chemicals, biohazards without aerosol exposure	General use; Chemical, Biological, Radiation, and Physical Hazards
	Flame resistant 	Flame resistant (e.g. Nomex or flame resistant cotton)	Working with water or air reactive chemicals, large volumes of organic solvents, potentially explosive chemicals

Gowns	Disposable gowns 	Clothing and skin protection	Working with biohazards
	Tyvek 	High tear resistance, protection from particulates	Working with biohazards with potential for exposure to airborne transmissible disease
Safety glasses		Polycarbonate lens, side shields for eye protection; meets ANSI and OSHA specifications	Working with physical hazards; laboratory work
Goggles		Tight fitting, protects eyes from impact, spray, paint, chemicals, flying chips, dust particles; polycarbonate lens, indirect ventilation, meets ANSI and OSHA specifications	Working with large volumes of corrosive liquids, small to large volumes of acutely toxic corrosives; working with large volumes of organic solvents, acutely toxic or hazardous chemicals, etc.
	Laser goggles 	Appropriately shaded goggles; optical density based on beam parameters	Working with Class 3 or Class 4 lasers
PPE	Specific Type	Characteristics	Applications
Face shield		Chemical resistant face shield	For use with mild acids, caustics, aromatic hydrocarbons, methylene chloride; splash hazard; air or water reactive or potentially explosive chemicals

Safety shield		Acrylic, weighted shield, three sided, benchtop shield, frosted edges	Protects from chemical splash, beta radiation, exposure to bloodborne pathogens
Respirators	Surgical mask 	Used for bacterial filtration	Working with live animals; working with infectious material with potential aerosol exposure
	N-95 	Protects against dusts, fumes, mists, microorganisms	Working with live animals or infectious materials with known airborne transmissible disease; dusty environments
	Half face **NOTE: Approval from EH&S is required before use of this type of respirator** 	Air purifying respirator protects against variety of particulates, vapors, dust, mists, fumes; depends on filter cartridge used	Working with live animals or infectious materials with known airborne transmissible disease; dusty environments; chemical vapors; particulates

SOP Template for Work with Hazardous Substances

Date:
Principal Investigator/Lab Supervisor:
Room & Building:

Section 1: Describe Process.

List the hazardous chemicals or operational hazards in this procedure, including concentration if applicable.

Section 2: Potential Hazards.

Describe the potential hazards; include physical and health hazards (ex. flammable, corrosive, reactive/unstable, carcinogen, reproductive toxin, etc.)

Section 3: Personal Protective Equipment.

Identify the required level of PPE and hygiene practices needed. PPE includes gloves, aprons, lab coats, eye protection, etc.

Section 4: Engineering Controls.

Describe engineering controls that will be used to prevent or reduce employee exposure to hazardous chemicals. This includes ventilation devices such as fume hoods. Include room number and location.

Section 5: Special Handling and Storage Requirements.

List storage requirements for hazardous chemicals involved with the SOP, including designated use areas, and policies regarding access to chemicals. Special procedures such as dating peroxide-forming chemicals and using secondary containment to transport chemicals are appropriate here.

Section 6: Spill and Accident Procedures.

Indicate how spills or accidental releases will be handled and by whom. List the location of appropriate emergency equipment (spill kit, eye washes, showers, and fire equipment). Any special requirements for personnel exposure should be identified here. If there is a spill or accident with a particularly hazardous substance, promptly notify both the supervisor and EH&S @ 6103

Section 7: Decontamination Procedures.

Specify decontamination procedures to be used for equipment, glassware, and clothing: including equipment such as glove boxes, hoods, lab benches, and controlled areas within the lab.

Section 8: Waste Disposal Procedures.

Indicate how waste will be contained and disposed of.

Section 9: Material Safety Data Sheet (MSDS) Locations.

Indicate the location of the MSDS for each hazardous chemical. Also, indicate the location of other pertinent safety information, i.e. equipment manuals, chemical references, etc.

Self-reactive Substances

What are unstable chemicals?

Unstable or self-reactive substances are chemicals which have the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, temperature, light, or contact with another material. Major types of highly reactive chemicals are explosives, peroxides, water-reactives, and pyrophorics.

What should I do when handling unstable chemicals?

- Always wear safety goggles, closed toe shoes, and gloves
- Handle under a hood if the reaction has the potential of creating gases
- If there is a chance of explosion, use barriers or other forms of isolation methods
- For some heat sensitive materials, temperature should be controlled.
- Date all containers when received or opened

Water-reactive Materials

What are water reactive materials?

Water reactive substances are dangerous when wet because they undergo a chemical reaction with water. This reaction may release a gas that is either flammable or presents a toxic health hazard. In addition, the heat generated when water contacts such materials is often enough for the item to spontaneously combustor explode.

How should I handle water reactive materials?

- Always wear safety goggles, gloves, lab coat and closed toe shoes
- Use a fume hood if there is a possibility of gases forming in the reaction
- Store in a cool dry area away from other chemicals
- Wash hands and work station after use

Here are some examples of water-reactive materials:

Name/Description	CAS Number
Aluminum alkyl halides	
Aluminum alkyl hydrides	
Aluminum alkyls	
Aluminum borohydride or Aluminum borohydride in devices	16962-07-5
Aluminum Carbide	1299-86-1
Aluminum ferrosilicon powder	
Aluminum hydride	7784-21-6
Aluminum phosphide	20859-73-8
Aluminum powder, uncoated	7429-90-5
Aluminum silicon powder, uncoated	
Barium	7440-39-3
Boron trifluoride dimethyl etherate	353-42-4
Calcium	7440-70-2
Calcium carbide	75-20-7
Calcium cyanamide with more than 0.1 percent of calcium carbide	156-62-7
Calcium hydride	7789-78-8
Calcium manganese silicon	
Calcium phosphide	1305-99-3
Calcium silicide	12737-18-7
Cells, containing sodium	
Cerium, turnings or gritty powder	7440-45-1
Cesium or Caesium	7440-46-2
Diethylzinc	
Dimethylzinc	544-97-8
Ethyldichlorosilane	1789-58-8
Ferrosilicon, with 30 percent or more but less than 90 percent silicon	8049-17-0
Lithium	7439-93-2

Lithium alkyls	
Lithium aluminum hydride	16853-85-3
Lithium aluminum hydride, ethereal	16853-85-3
Lithium borohydride	16949-15-8
Lithium ferrosilicon	70399-13-2
Lithium hydride	7580-67-8
Lithium hydride, fused solid	7580-67-8
Lithium nitride	26134-62-3
Lithium silicon	68848-64-6
Magnesium alkyls	
Magnesium aluminum phosphide	
Magnesium granules, coated, particle size not less than 149 microns	7439-95-4
Magnesium hydride	7693-27-8
Magnesium phosphide	12057-74-8
Magnesium silicide	22831-39-6
Magnesium, powder or Magnesium alloys, powder	7439-95-4
Maneb or Maneb preparations with not less than 60 percent maneb	12427-38-2
Methyl magnesium bromide, in ethyl ether	
Methyldichlorosilane	75-54-7
Phosphorus pentasulfide, free from yellow or white phosphorus	7723-14-0
Potassium	7440097
Potassium borohydride	13762-51-1
Potassium phosphide	20770-41-6
Potassium sodium alloys	1113581-2
Potassium, metal alloys	7440097
Rubidium	7440-17-7
Sodium	7440-23-5
Sodium aluminum hydride	13770-96-2
Sodium borohydride	16940-66-2
Sodium hydride	7646-69-7
Sodium phosphide	24167-76-8
Stannic phosphide	25324-56-5
Strontium phosphide	12504-13-1

Trichlorosilane	10025-78-2
Zinc ashes	
Zinc phosphide	1314-84-7
Zinc powder or Zinc dust	

Pyrophoric Materials

What are pyrophoric materials?

Pyrophorics are materials that will ignite spontaneously in air. The flame is often invisible.

How should I handle pyrophoric materials?

- Never work alone
- Solids must be transferred in inert atmospheres
- Liquids should be stored in sealed containers with PTFE-lined septa to prevent air exposure.
- Handling of liquid pyrophorics must be conducted via cannula or syringe transfer to prevent exposure to air if not manipulated within an inert atmosphere
- Do not let the pyrophoric material come in contact with any combustible materials, including paper products
- Needles should be equipped with locking mechanisms to prevent accidental disconnection and release of reagents
- Use a shield or hood with the sash at the lowest possible height whenever possible

What are some examples of pyrophoric materials?

- organo-metallic reagents (i.e. Grignard reagents)
- alkali earth elements (sodium, potassium, cesium)
- finely divided metals (Raney nickel, aluminum powder, zinc dust)
- metal hydrides (sodium hydride, germane, lithium aluminum hydride)
- alkyl metal hydrides (butyllithium, trimethylaluminum, triethylboron)
- metal carbonyls (nickel carbonyl, iron pentacarbonyl)
- gases (arsine, diborane, phosphine, silane)
- silicon halides (dichloromethylsilane

What if I spill something pyrophoric?

- Powdered lime or sand can be used to smother the flame
- DO NOT use water or a fire extinguisher for these spills

- If the material make contact with the skin or eyes, flush completely with water for 15 minutes
- Seek first aid for any burns

Organic Peroxides

What are organic peroxides?

Organic peroxides, or peroxidizable chemicals are materials that undergo a reaction with the oxygen in the air to form peroxides. These peroxides can decompose or explode with impact, heat or friction.

What are some common types of organic peroxides?

- dialkyl peroxides
- hydroperoxides
- diacyl peroxides
- peroxydicarbonates
- peroxyesters
- ketone peroxides
- peroxyketals
- alkylperoxy carbonates

What are the different classes of organic peroxides?

Class 1-describes those formulations which are capable of deflagration, but not detonation

Class 2- describes those formulations that burn very rapidly and that present a severe reactivity hazard.

Class 3-describes those formulations that burn rapidly and that present a moderate reactivity hazard.

Class 4- describes those formulations that burn in the same manner as ordinary combustibles and that present a minimal reactivity hazard

Class 5-describes those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that present no reactivity hazard

How do I properly handle organic peroxides?

- Always store at the temperature recommended by the manufacturer
- Never return unused material back to the original container.
- Only use clean equipment and work in a clean environment
- Always wear proper personal protective equipment, such as goggles, lab coat and closed toe shoes
- Avoid breathing in any dust or mists given off by the materials

Corrosive Materials

What are corrosive materials?

Corrosives are chemicals that can cause damage or irritation to tissue that it comes in contact with. Some can even cause damage to metal. They can come in solid, liquid or gas form and are often strong acids, bases or dehydrating agents.

- Corrosive gases-- are readily absorbed into the body through skin contact and inhalation.
- Corrosive liquids-- are frequently used in the laboratory and have a high potential to cause external injury to the body.
- Corrosive solids-- cause delayed injury. Because corrosive solids dissolve rapidly in moisture on the skin and in the respiratory system, the effects of corrosive solids depend largely on the duration of contact.

How should I handle corrosive materials?

- Always wear proper safety goggles, gloves, lab coat and closed toe shoes
- Always add acids or bases to water (not the reverse)
- Liquid corrosives should be stored below eye level
- Finish dispensing one material and close lid before dispensing another
- If the chemical has any inhalation hazards, handle under a fume hood
- Decontaminate the area after use by flushing with large amounts of water

What are some examples of corrosive materials?

ORGANIC ACIDS	ORGANIC BASES	INORGANIC ACIDS
Formic Acid	Ethylenediamine	Hydrofluoric Acid

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

	Sodium Hydride	Antimony Trichloride
	Hydrazine	Ammonium Bifluoride
	Ammonium Sulfide	Calcium Fluoride
	Calcium Oxide	Ferric Chloride
		Sodium Bisulfate
		Sodium Fluoride

APSU Chemical Hygiene Plan Section 5:

LAB SPECIFIC STANDARD OPERATING PROCEDURES

The standard operating procedures (SOPs) reflect the safety practices that your lab is following to comply with OSHA requirements for safe handling of hazardous materials. To ensure compliance, all personnel who will be working with these materials must have a uniform understanding of the practices to be followed. They must be knowledgeable of the contents of these documents, and know how to readily access them in the event of an inspection or emergency.

5.1 Getting Started

Start with what you have. Put a copy of your lab-specific standard operating procedures (SOPs) here. If your SOPs are lengthy, it is acceptable to put them into a separate binder nearby that is labeled as "SOPs." If your SOPs are already in another binder, simply store it near the CHP binder and label it as above.

SOPs should identify the **particularly hazardous chemicals** or dangerous procedures in your lab. This would include use of chemicals that have the following characteristics:

- **Carcinogens**
- **Reproductive toxins**
- **Acutely toxic**
- **Highly flammable**
- **Reactive or explosive**

Include a "Special Provisions for Work with Particularly Hazardous Chemicals or Dangerous Procedures" section in the final SOPs. There are many different ways to incorporate safety practices into the lab SOPs. The objective is to identify the hazards, describe necessary safety practices (e.g. "Work with xylene will only be done in the fume hood.") and personal protective equipment (e.g. "Nitrile gloves will be worn any time you work with Osmium compounds."). In other words, make a special note of what is dangerous in your lab and how to minimize those dangers. Ensure that all such provisions are documented in this tab.

5.2 Special Precautions for Carcinogens, Reproductive Toxins, and Substances with High Toxicity

When laboratory procedures include the use of highly hazardous chemicals, **special precautions** shall be implemented as deemed necessary by the lab supervisor. These precautions must be stated clearly in the SOPs and include the following provisions:

Establishment of a **designated area** for the use of highly hazardous chemicals, for example, a fume hood or a designated work bench.

Signage and access control to the work area where the chemical is used.

Special precautions such as use of **containment devices** such as glove boxes; **isolation** of contaminated equipment; practicing good laboratory **hygiene**; and **prudent transportation** (including secondary containment) of very toxic chemicals.

Planning for accidents and spills.

Special **storage and waste disposal** practices.

Below is a template of an SOP that outlines each of these areas of emphasis. If you already have an SOP document, ensure that it at least includes sections similar to the template below. For additional guidance reference *Prudent Practices in the Laboratory,* published by the National Research Council. It is a useful reference which has detailed recommendations for work with particularly hazardous substances and is available online at http://www.nap.edu/catalog.php?record_id=12654 .

5.3 SOP Templates and Examples

Please see the following pages in this binder for templates and examples of standard operating procedures.

5.3.1 SOP Template for Work with Hazardous Substances

Date:
Principal Investigator/Lab Supervisor:
Room & Building:

Section 1: Describe Process.

List the hazardous chemicals or operational hazards in this procedure, including concentration if applicable.

Section 2: Potential Hazards.

Describe the potential hazards. Include physical and health hazards (e.g. flammable, corrosive, reactive/unstable, carcinogen, reproductive toxin, etc.)

Section 3: Personal Protective Equipment.

Identify the required level of PPE and hygiene practices needed. PPE includes gloves, aprons, lab coats, eye protection, etc.

Section 4: Engineering Controls.

Describe engineering controls that will be used to prevent or reduce employee exposure to hazardous chemicals. This includes ventilation devices such as fume hoods. Include room number and location.

Section 5: Special Handling and Storage Requirements.

List storage requirements for hazardous chemicals involved with the SOP, including designated use areas, and policies regarding access to chemicals. Special procedures such as dating peroxide-forming chemicals and using secondary containment to transport chemicals are appropriate here.

Section 6: Spill and Accident Procedures.

Indicate how spills or accidental releases will be handled and by whom. List the location of appropriate emergency equipment (spill kit, eye washes, showers, and fire equipment). Any special requirements for personnel exposure should be identified here. If there is a spill or accident with a particularly hazardous substance, promptly notify both the supervisor and the APSU EHS Office at ext. 7456.

Section 7: Decontamination Procedures.

Specify decontamination procedures to be used for equipment, glassware, and clothing, including equipment such as glove boxes, hoods, lab benches, and controlled areas within the lab.

Section 8: Waste Disposal Procedures.

Indicate how waste will be contained and managed for disposal.

Section 9: Safety Data Sheet (SDS) Locations.

Indicate the location of the SDS for each hazardous chemical. Also, indicate the location of other pertinent safety information, i.e. equipment manuals, chemical references, etc.

*APSU Safety Data Sheets are available online from APSU Onestop, then choose the Life tab and scroll to the bottom of the page. There is a link to MSDSOnline on the left hand side.

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with flammable materials. This general use SOP only addresses safety issues specific to flammability hazards of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., both general use SOPs for flammable liquids and particularly hazardous substances would apply to benzene). If you have questions concerning the applicability of any item listed in this procedure contact the Principal Investigator/Laboratory Supervisor of your laboratory.

#2	Hazardous Chemicals/Class of Hazardous Chemicals

For the purposes of laboratory safety, both flammable and combustible liquids are considered fire hazards. Flammable liquids have a flash point of less than 100 °F and combustible liquids have a flash point of between 100-200 °F.

#3	Control of Hazards- General

Do not heat flammable chemicals with an open flame.

For highly flammable chemicals, avoid static electricity or hot surfaces as they can serve as ignition sources.

Do not use electrical devices with cracked or frayed electrical wiring.

When transferring flammable liquid from a bulk container (generally greater than five gallons), the containers must be electrically bonded and grounded.

Transfer flammable liquids from containers of five gallon-capacity or less inside a laboratory hood (or other area with similar ventilation) to prevent accumulation of flammable concentration of vapors.

#3a	Engineering/Ventilation Controls

Flammable and combustible chemicals should be used in lab fume hoods (or other well ventilated areas) whenever possible, especially when used in larger quantities (> 500mL) or when using above room temperature and/or pressure. NOTE: Certain flammables that are also considered particularly hazardous substances (i.e., benzene) may require use of a fume hood (due to toxicity potential).

#3b	Personal Protective Equipment

At minimum, safety glasses, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals.

Additionally:

When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review chemical MSDS and APSU PPE selection guidance.

Goggles (vs. safety glasses) are appropriate in processes where splash or spray is possible.

For hazardous chemicals that are toxic via skin contact/absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact with body/skin is possible.

#4 Special Handling Procedures and Storage Requirements

Where greater than 10 gallons of flammables are kept, such materials must be stored within a flammable storage cabinet.

Fire extinguishers appropriate for the fire hazards present must be available in all laboratories and storage areas. Class D fire extinguishers must be available in the immediate work area when working with flammable metals such as magnesium, sodium, and potassium.

Ensure secondary containment and segregation of incompatible chemicals per guidance within the APSU Chemical Hygiene Plan. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5 Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment. For further guidance, refer to Hazardous Waste and Spills.

Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

Symptoms or signs of exposure to a hazardous chemical develop.

#6 Waste Disposal

Many flammable liquids intended for disposal may likely be considered hazardous wastes. For general guidance regarding waste disposal, refer to Hazardous Waste and Spills in the CHP binder.

#7 Minimum Training Requirements

Laboratory Safety (EHS)

Laboratory-specific training (Departmental)

Fire Extinguisher Use (EHS) - recommended

#8 Decontamination Procedures

Personnel: If immediate medical attention is required, call 911. Remove any contaminated clothing, and IMMEDIATELY flush contaminated skin with water for at least 15 minutes following any skin contact. For eye exposures, IMMEDIATELY / flush eyes w/ water for at least 15 minutes.

Consult MSDS for guidance on appropriate first aid. Where medical attention is required, ensure to bring along MSDS(s) of chemical(s) to aid medical staff in proper diagnosis and treatment.

Area: Decontamination procedures vary depending on the material being handled. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.

#9 Designated Area

For flammables that are also considered particularly hazardous substances, a designated area shall be established per the other applicable SOP(s).

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with corrosive materials. This general use SOP only addresses safety issues specific to corrosive hazards of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for perchloric acid, both the general use SOPs for corrosives and unstable reactives would apply). If you have questions concerning the applicability of any item listed in this procedure contact the Principal Investigator/Laboratory Supervisor of your laboratory.

#2	Hazardous Chemicals/Class of Hazardous Chemicals

Corrosive materials cause destruction of tissue through chemical action at the point of contact. As corrosive chemicals can be liquids, solids, or gases, corrosive effects most commonly affect the skin, eyes, and respiratory tract. Examples of corrosive chemicals include: liquids such as acids and bases, bromine, and hydrogen peroxide; gases such as chlorine and ammonia; and solids such as phosphorous and phenol.

#3	Control of Hazards- General

Handling processes should be designed to minimize the potential for splash, splatter, or other likely scenarios for accidental contact.

Do not pour water into acid. Slowly add the acid to the water and stir.

Never empty carboys or drums of chemicals by means of air pressure. Use a tilting rack, a safety siphon, or a liquid pump.

Use a mechanical aid or a pipette bulb for pipetting.

Open bottles or carboys slowly and carefully and wear protective equipment to guard hands, face, and body from splashes, vapors, gases and fumes.

Wipe drips from containers and bench tops. Be especially careful to wipe up visible residues of sodium hydroxide and potassium hydroxide from all surfaces. Skin contact with dry residue will result in burns.

#3a	Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling strong acids/ bases, or other chemicals that can form mists/ vapors upon contact with air (often referred to as "fuming").

#3b	Engineering/Ventilation Controls

When handling corrosive materials, minimally wear the following PPE:

Safety goggles (+ face shield when splash potential exists)

Laboratory coat (+ apron and/or over sleeves to match the chemical where contact with body or skin is foreseeable).

Protective gloves to match the potential chemical hazards.

Long pants and close toed shoes

#4	Special Handling Procedures and Storage Requirements

Ensure secondary containment and segregation of incompatible chemicals per guidance within the APSU Chemical Storage tab in Chemical Hygiene Plan. Also, follow any substance-specific storage guidance provided in MSDS documentation.

Corrosives should never be stored above eye level.

Wherever hydrofluoric acid is used, ensure to have a calcium gluconate kit on-site.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse effects to the environment. For further guidance, refer to Hazardous Waste and Spills in the Chemical Hygiene Plan.

Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

Symptoms or signs of exposure to a hazardous chemical develop.

#6	Waste Disposal

Many corrosive liquids intended for disposal may likely be considered hazardous wastes. For general guidance regarding waste disposal, refer to Hazardous Waste and Spills in the CHP binder.

#7	Training Requirements

Laboratory Safety (EHS)

Laboratory-specific training (Departmental)

#8	Decontamination Procedures

Personnel: If immediate medical attention is required, call 911. Remove any contaminated clothing, and IMMEDIATELY flush contaminated skin with water for at least 15 minutes following any skin contact. For eye exposures, IMMEDIATELY flush eyes with water for at least 15 minutes.

Consult MSDS for guidance on appropriate first aid. Where medical attention is required, ensure to bring along MSDS(s) of chemical(s) to aid medical staff in proper diagnosis and treatment.

All incidents involving exposure to hydrofluoric acid, phenol, or other severe skin contact hazards require immediate medical attention. Additionally seek medical attention if pain, numbness, redness, irritation or other health symptoms are apparent. Check the MSDS to see if any delayed effects should be expected.

Area: Decontamination procedures vary depending on the material being handled. The corrosivity of some materials can be neutralized with other reagents. Special neutralizing agents should be on hand to decontaminate areas.

#9	Designated Area

For corrosives that are also considered particularly hazardous substances, a designated area shall be established per the other applicable SOP(s).

#1 Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with highly reactive/unstable materials. This SOP is generic in nature and only addresses safety issues pertaining to reactivity/stability hazards of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for perchloric acid, both general use SOPs for highly reactive/ unstable materials and corrosives would apply). If you have questions concerning the applicability of any item listed in this procedure contact the Principal Investigator/Laboratory Supervisor of your laboratory.

#2 Hazardous Chemicals/Class of Hazardous Chemicals

Highly reactive or unstable materials are those that have the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, temperature, light, or contact with another material. Major types of highly reactive chemicals are explosives, peroxides, water-reactives, and pyrophorics.

#3 Control of Hazards- General

Minimize the quantity of reactive chemicals used or synthesized to the smallest amount needed.

Handle reactive chemicals with caution. Appropriate chemical-specific precautions must be taken for mixing even small quantities with other chemicals.

Chemical reactions conducted at temperatures or pressures above or below ambient conditions must be performed in a manner that minimizes risk of explosion or vigorous reaction.

Provide a mechanism for adequate temperature control and heat dissipation.

Utilize shields and barricades, and personal protective equipment (such as face shields with throat protectors and heavy gloves) whenever there is a possibility of explosion or vigorous chemical reaction.

Glass equipment operated under vacuum or pressure must be shielded, wrapped with tape, or otherwise protected from shattering.

#3a Engineering/Ventilation Controls

As many reactive materials liberate combustible and/or toxic gas when exposed to water vapor or air, they should be used in a lab hood to prevent hazardous buildup of gases.

#3b Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals. Additionally:

Utilize shields and barricades, and personal protective equipment (such as face shields with throat protectors and heavy gloves) whenever there is a possibility of explosion or vigorous chemical reaction.

When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review chemical MSDS.

Goggles (not safety glasses) are appropriate for processes where splash or spray is foreseeable.

For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact with body/skin is likely.

#4 Special Handling Procedures and Storage Requirements

Ensure careful handling of handling materials that may be sensitive to shock, heat, friction, or light.

Ensure secondary containment and segregation of incompatible chemicals per guidance within the APSU Chemical Hygiene Plan. Also, follow any substance-specific storage guidance provided in MSDS documentation.

Label all chemicals with date received and date opened and if an appropriate expiration date does not exist, assign one as provided within APSU Guidelines on Peroxide Forming Chemicals.

Any chemicals with crystallization, visible discoloration, or liquid stratification potentially have undergone peroxidation and must not be used or otherwise disturbed. Refer to the APSU Guidelines on Peroxide Forming Chemicals.

#5 Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment. For further guidance, refer to Hazardous Waste and Spills in the CHP.

Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

Symptoms or signs of exposure to a hazardous chemical develop.

#6 Waste Disposal

Many reactive/ unstable materials intended for disposal may likely be considered hazardous wastes. For general guidance regarding waste disposal, refer to Hazardous Waste and Spills in the CHP binder.

#7 Minimum Training Requirements

Laboratory Safety (EHS)

Laboratory-specific training (Department)

#8 Decontamination Procedures

Personnel: If immediate medical attention is required, call 911. Remove any contaminated clothing, and IMMEDIATELY flush contaminated skin with water for at least 15 minutes following any skin contact. For eye exposures, IMMEDIATELY flush eyes with water for at least 15 minutes.

Consult MSDS for guidance on appropriate first aid. Where medical attention is required, ensure to bring along MSDS(s) of chemical(s) to aid medical staff in proper diagnosis and treatment.

Area: Decontamination procedures vary depending on the material being handled. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.

#9 Designated Area

For highly reactive/unstable materials that are also considered particularly hazardous substances, a designated area shall be established per other applicable SOPs.

#1 Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with compressed gases. This general use SOP only addresses safety issues specific to compressed gases. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for flammable gases, both this general use SOP and the general use SOP for flammables would apply). If you have questions concerning the applicability of any item listed in this procedure contact the Principal Investigator/Laboratory Supervisor of your laboratory.

#2 Hazardous Chemicals/Class of Hazardous Chemicals

Compressed gases have inherent pressure hazards and can also create health hazardous and/ or flammable atmospheres. Common hazard characteristics of gases include flammability, toxicity, and corrosivity. A few gases (i.e., silane, diborane, phosphine) are considered pyrophoric (will ignite spontaneously in air).

One additional hazard property common to all compressed gases is the substantial volume expansion when released to air. Gas release in an inadequately ventilated room can create an oxygen-deficient environment.

#3 Control of Hazards- General

Check connections and hoses regularly for leaks using a specific monitoring instrument or soapy water (or equivalent).

When using highly flammable or toxic gas, check the delivery system using an inert gas prior to introducing the hazardous gas.

When using compressed acetylene: (i) do not exceed a working pressure of 15 psig, and (ii) do not use vessels, piping, or other materials that contain a significant amount of copper (usually considered to be more than 50% copper).

Replace valve caps when cylinders are not in use or before moving.

Remove damaged or defective cylinders from service (contact the cylinder vendor for assistance).

#3a Engineering/Ventilation Controls

Make sure the gas use and/or storage is in well-ventilated areas (i.e., lab ventilation having a minimum of 6 air changes per hour).

#3b Personal Protective Equipment

At minimum, lab coats, safety glasses, and closed toed shoes should be worn when handling compressed gases. Depending on the hazard characteristics, additional protective equipment may be necessary.

#4 Special Handling Procedures and Storage Requirements

Safe Handling:

Compressed gas cylinders must be transported using hand-trucks or other appropriate means. **NEVER TRANSPORT UNSECURED COMPRESSED GAS CYLINDERS!**

Cylinders should be transported upright whenever possible (always transport acetylene in an upright (vertical) position).

Elevators can be a confined space – NEVER ride in an elevator with compressed gas cylinders. Have one person send the elevator and another person receive the elevator.

Safe Storage:

Secure compressed gas cylinders (>26" tall) to an anchored rack using two metal chains (at 1/3 and 2/3 cylinder height).

No more than two cylinders may be secured with one pair of chains.

Segregate and clearly mark full and empty ("MT") cylinders.

Store compressed gas cylinders away from heat sources, and flammable and highly combustible materials (such as oil and greases).

Segregate according to hazard class and chemical compatibility. Ensure to separate flammable and oxidizing gases.

Store flammable gases away from flammable solvents, combustible material, ignition sources (including unprotected electrical connections), and oxygen gas cylinders and liquid oxygen (at least 20 feet if possible).

Additionally, follow all substance-specific storage guidance provided in MSDS documentation.

#5 Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse effects to the environment. For further guidance, refer to Hazardous Waste and Spills in the CHP binder.

Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

Symptoms or signs of exposure to a hazardous chemical develop.	
#6	**Waste Disposal**
Coordinate with vendor for return of cylinders.	
#7	**Minimum Training Requirements**
Laboratory Safety (EHS) Laboratory-specific training (Department)	
#8	**Decontamination Procedures**
Not applicable	
#9	**Designated Area**
For compressed gases that are also considered particularly hazardous chemicals, a designated area shall be established per the other applicable SOP(s).	

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with carcinogenic materials. This general use SOP only addresses safety issues specific to carcinogenic hazards of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for benzene, both general use SOPs for flammables and carcinogens would apply). If you have questions concerning the applicability of any item listed in this procedure contact the Principal Investigator/Laboratory Supervisor of your laboratory.

#2	Hazardous Chemicals/Class of Hazardous Chemicals

A carcinogen is a substance or agent that meets one of the following criteria:

It is regulated by TOSHA as a carcinogen.

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 (IARC)

It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(a) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;

(b) After repeated skin application of less than 300 mg/kg of body weight per week; or

(c) After oral dosages of less than 50 mg/kg of body weight per day.

#3	Control of Hazards - General

Although the specific SOPs will vary according to the material used, the following guidelines are generally applicable for projects involving carcinogens:

Use the smallest amount of chemical that is consistent with the requirements of the work to be performed.

Use containment devices (such as lab fume hoods or glove boxes) when: (i) volatilizing these substances, (ii) manipulating substances that may generate aerosols, and (iii) performing laboratory procedures that may result in uncontrolled release of the substance.

Use high efficiency particulate air (HEPA) filters, carbon filters, or scrubber systems with containment devices to protect effluent and vacuum lines, pumps, and the environment whenever feasible.

Use ventilated containment to weigh out solid chemicals. Alternatively, the tare method can be used to prevent inhalation of the chemical. While working in a laboratory hood, the chemical is added to a pre-weighed container. The container is then sealed and can be re-weighed outside of the hood. If chemical needs to be added or removed, this manipulation is carried out in the hood. In this manner, all open chemical handling is conducted in the laboratory hood.

#3a	Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling carcinogens.

#3b	Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals. Additionally:

When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review the chemical MSDS.

Goggles (not safety glasses) are appropriate for processes where splash or spray is foreseeable.

For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., face shield, apron, oversleeves) is appropriate where chemical contact w/ body/skin is foreseeable.

#4	Special Handling Procedures and Storage Requirements

Ensure secondary containment and segregation of incompatible chemicals per guidance within the APSU Chemical Hygiene Plan. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse effects to the environment. For further guidance, refer to Hazardous Waste and Spills in the CHP binder.

Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

Symptoms or signs of exposure to a hazardous chemical develop.

#6 Waste Disposal

Carcinogens intended for disposal are considered hazardous wastes. For general guidance regarding waste disposal, refer to Hazardous Waste and Spills in the CHP binder.

#7 Minimum Training Requirements

Laboratory Safety (EHS)

Laboratory-specific training (Department)

#8 Decontamination Procedures

Personnel: Immediately after working with carcinogens, remove gloves, wash hands and arms with soap and water.

Area: Decontamination procedures vary depending on the material being handled; consult the MSDS. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.

Equipment: Decontaminate vacuum pumps or other contaminated equipment (glassware) before removing them from the designated area.

#9 Designated Area

For use of carcinogens, a designated area shall be established where limited access, special procedures, knowledge, and work skills are required. A designated area can be the entire laboratory, a specific laboratory workbench, or a laboratory hood. Designated areas must be clearly marked with signs that identify the chemical hazard and include an appropriate warning, for example: WARNING! FORMALDEHYDE WORK AREA – CARCINOGEN.

Upon leaving the designated area, remove any personal protective equipment worn and wash hands, forearms, face, and neck.

After each use (or day), wipe down the immediate work area and equipment to prevent accumulation of chemical residue.

At the end of each project, thoroughly decontaminate the designated area before resuming normal laboratory work in the area.

#1 Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with reproductive toxins. This SOP is generic in nature and only addresses safety issues specific to reproductive toxicity of chemicals. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammables and reproductive toxins would apply to benzene). If you have questions concerning the applicability of any item listed in this procedure contact the Principal Investigator/Laboratory Supervisor of your laboratory.

#2 Hazardous Chemicals/Class of Hazardous Chemicals

A reproductive toxin is a chemical that affects the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

#3 Control of Hazards- General

Although the specific SOPs will vary according to the material used, the following guidelines are generally applicable for projects involving reproductive toxins:

Use the smallest amount of chemical that is consistent with the requirements of the work to be performed.

Use containment devices (such as lab fume hoods or glove boxes) when: (i) volatilizing these substances, (ii) manipulating substances that may generate aerosols, and (iii) performing laboratory procedures that may result in uncontrolled release of the substance.

Use high efficiency particulate air (HEPA) filters, carbon filters, or scrubber systems with containment devices to protect effluent and vacuum lines, pumps, and the environment whenever feasible.

Use ventilated containment to weigh out solid chemicals. Alternatively, the tare method can be used to prevent inhalation of the chemical. While working in a laboratory hood, the chemical is added to a pre-weighed container. The container is then sealed and can be re-weighed outside of the hood. If chemical needs to be added or removed, this manipulation is carried out in the hood. In this manner, all open chemical handling is conducted in the laboratory hood.

#3a Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling reproductive toxins.

#3b Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals. Additionally:

When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review chemical MSDS.

Goggles (not safety glasses) are appropriate for processes where splash or spray is foreseeable.

For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact with body/skin is foreseeable.

#4	Special Handling Procedures and Storage Requirements

Ensure secondary containment and segregation of incompatible chemicals per guidance within the APSU Chemical Hygiene Plan. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment. For further guidance, refer to Hazardous Waste and Spills in the CHP binder.

Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

Symptoms or signs of exposure to a hazardous chemical develop.

#6	Waste Disposal

Reproductive toxins intended for disposal are considered hazardous wastes. For general guidance regarding waste disposal, refer to Hazardous Waste and Spills in the CHP binder.

#7	Minimum Training Requirements

Laboratory Safety (EHS)

Laboratory-specific training (Department)

#8	Decontamination Procedures

Personnel: Immediately after working with reproductive toxins, remove gloves and wash hands and arms with soap and water.

Area: Decontamination procedures vary depending on the material being handled. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.

Equipment: Decontaminate vacuum pumps or other contaminated equipment (glassware) before removing them from the designated area.

#9	Designated Area

For use of reproductive toxins, a designated area shall be established where limited access, special procedures, knowledge, and work skills are required. A designated area can be the entire laboratory, a specific laboratory workbench, or a laboratory hood. Designated areas must be clearly marked with signs that identify the chemical hazard and include an appropriate warning; for example: WARNING! BENZENE WORK AREA – CARCINOGEN/ REPRODUCTIVE TOXIN.

Upon leaving the designated area, remove any personal protective equipment worn and wash hands, forearms, face, and neck.

After each use (or day), wipe down the immediate work area and equipment to prevent accumulation of chemical residue.

At the end of each project, thoroughly decontaminate the designated area before resuming normal laboratory work in the area.

#1 Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with materials having high acute toxicity, also referred to as highly toxic materials. This SOP is generic in nature and only addresses safety issues specific to the high acute toxicity of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for carbon monoxide gas, general use SOPs for highly toxics, flammables, and compressed gases could apply). If you have questions concerning the applicability of any item listed in this procedure contact the Principal Investigator/Laboratory Supervisor of your laboratory.

#2 Hazardous Chemicals/Class of Hazardous Chemicals

A highly toxic material is considered a chemical falling within any of the following categories:

A chemical with a median lethal dose (LD50) of 50 mg or less per Kg of body weight when administered orally to albino rats weighing between 200 and 300 gm each.

A chemical with a median lethal dose (LD50) of 200 mg or less per Kg 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 Kg each.

A chemical that has a median lethal concentration (LC50) in air of 5000 ppm by volume or less of gas or vapor, or 50 mg 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 gm each.

#3 Control of Hazards- General

Although the specific SOPs will vary according to the material used, the following guidelines are generally applicable for projects involving highly toxic materials:

Use the smallest amount of chemical that is consistent with the requirements of the work to be performed.

Use containment devices (such as lab fume hoods or glove boxes) when: (i) volatilizing these substances, (ii) manipulating substances that may generate aerosols, and (iii) performing laboratory procedures that may result in uncontrolled release of the substance.

Use high efficiency particulate air (HEPA) filters, carbon filters, or scrubber systems with containment devices to protect effluent and vacuum lines, pumps, and the environment whenever feasible.

Use ventilated containment to weigh out solid chemicals. Alternatively, the tare method can be used to prevent inhalation of the chemical. While working in a laboratory hood, the

chemical is added to a pre-weighed container. The container is then sealed and can be re-weighed outside of the hood. If chemical needs to be added or removed, this manipulation is carried out in the hood. In this manner, all open chemical handling is conducted in the laboratory hood.

#3a Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling highly toxic materials.

#3b Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals

Additionally:

When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review chemical MSDS.

Goggles (not safety glasses) are appropriate for processes where splash or spray is foreseeable.

For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact w/ body/ skin is foreseeable.

#4 Special Handling Procedures and Storage Requirements

Ensure secondary containment and segregation of incompatible chemicals per guidance within the APSU Chemical Hygiene Plan. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5 Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse effects to the environment. For further guidance, refer to Hazardous Waste and Spills in the CHP binder.

Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

Symptoms or signs of exposure to a hazardous chemical develop.

#6 Waste Disposal

Highly toxic materials intended for disposal are considered hazardous wastes. For general guidance regarding waste disposal, refer to Hazardous Waste and Spills in the CHP binder.

#7 Minimum Training Requirements

Laboratory Safety (EHS)

Laboratory-specific training (Department)

#8 Decontamination Procedures

Personnel: Immediately after working with highly acutely toxic materials, remove gloves and wash hands and arms with soap and water.

Area: Decontamination procedures vary depending on the material being handled. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.

Equipment: Decontaminate vacuum pumps or other contaminated equipment (glassware) before removing them from the designated area.

#9 Designated Area

For use of highly toxic materials, a designated area shall be established where limited access, special procedures, knowledge, and work skills are required. A designated area can be the entire laboratory, a specific laboratory workbench, or a laboratory hood. Designated areas must be clearly marked with signs that identify the chemical hazard and include an appropriate warning; for example: WARNING! HYDROFLUORIC ACID (HF) WORK AREA – HIGHLY TOXIC MATERIAL.

NOTE: Skin exposure to HF requires quick application of calcium gluconate gel. It is highly recommended the lab maintain a stock of this gel
http://www.calgonate.com/calgonate_gel.php

Upon leaving the designated area, remove any personal protective equipment worn and wash hands, forearms, face, and neck.

After each use (or day), wipe down the immediate work area and equipment to prevent accumulation of chemical residue. At the end of each project, thoroughly decontaminate the designated area before resuming normal laboratory work in the area.

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with sensitizers. As sensitizers often have other potential hazard characteristics such as carcinogenicity and corrosivity, ensure to account for these risks also. If you have questions concerning the applicability of any item listed in this procedure contact the Principal Investigator/Laboratory Supervisor of your laboratory.

#2	Hazardous Chemicals/Class of Hazardous Chemicals

A sensitizer (allergen) is a substance that causes exposed people to develop an allergic reaction in normal tissue after repeated exposure to the substance. Examples of compounds that may cause sensitization in some individuals are diazomethane, various isocyanates, formaldehyde, and benzylic and allylic halides.

#3	Control of Hazards- General

Handling processes should be designed to minimize the potential for splash, splatter, or other likely scenarios for accidental contact.

#3a	Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling sensitizers that can be inhaled (via mist/fume/gas/vapor).

#3b	Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals.

Additionally:

When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review the chemical MSDS.

Goggles (not safety glasses) are appropriate for processes where splash or spray is foreseeable.

For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact with body/skin is foreseeable.

#4	Special Handling Procedures and Storage Requirements

Ensure secondary containment and segregation of incompatible chemicals per guidance within the APSU Chemical Hygiene Plan. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5 Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse effects to the environment. For further guidance, refer to Hazardous Waste and Spills in the CHP binder.

Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

Symptoms or signs of exposure to a hazardous chemical develop.

#6 Waste Disposal

Many sensitizers intended for disposal may likely be considered hazardous wastes. For general guidance regarding waste disposal, refer to Hazardous Waste and Spills in the CHP binder.

#7 Minimum Training Requirements

Laboratory Safety (EHS)

Laboratory-specific training (Department)

#8 Decontamination Procedures

Personnel: If immediate medical attention is required, call 911. Remove any contaminated clothing and IMMEDIATELY flush contaminated skin with water for at least 15 minutes following any skin contact. For eye exposures, IMMEDIATELY flush eyes w/ water for at least 15 minutes.

Consult MSDS for guidance on appropriate first aid. Where medical attention is required, ensure to bring along MSDS(s) of chemical(s) to aid medical staff in proper diagnosis and treatment.

Area: Carefully clean work area after use. Decontamination procedures vary depending on the material being handled.

#9 Designated Area

For sensitizers that are also considered particularly hazardous substances, a designated area shall be established per the other applicable SOP(s).

General Use SOP for Irritants

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with irritants. As irritation is only a secondary health effect with many substances, ensure to account for other more significant hazards such as carcinogenicity and corrosivity. If you have questions concerning the applicability of any item listed in this procedure contact the Principal Investigator/Laboratory Supervisor of your laboratory.

#2	Hazardous Chemicals/Class of Hazardous Chemicals

Irritants are chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds are irritants; thus, skin contact with all laboratory chemicals should be avoided.

#3	Control of Hazards- General

Handling processes should be designed to minimize the potential for splash, splatter, or other likely scenarios for accidental contact.

#3a	Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling irritants that can be inhaled (via mist/fume/gas/vapor).

#3b	Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals.

Additionally:

When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review chemical MSDS.

Goggles (not safety glasses) are appropriate for processes where splash or spray is possible.

For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact with body/skin is foreseeable.

#4	Special Handling Procedures and Storage Requirements

Ensure secondary containment and segregation of incompatible chemicals per guidance within the APSU Chemical Hygiene Plan. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse effects to the environment. For further guidance, refer to Hazardous Waste and Spills in the CHP binder.

Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

Symptoms or signs of exposure to a hazardous chemical develop.

#6	Waste Disposal

Irritant substances intended for disposal may likely be considered hazardous wastes. For general guidance regarding waste disposal, refer to Hazardous Waste and Spills in the CHP binder.

#7	Minimum Training Requirements

Laboratory Safety (EHS)

Laboratory-specific training (Departmental)

#8	Decontamination Procedures

Personnel: If immediate medical attention is required, call 911. Remove any contaminated clothing and IMMEDIATELY flush contaminated skin with water for at least 15 minutes following any skin contact. For eye exposures, IMMEDIATELY flush eyes w/ water for at least 15 minutes.

Consult MSDS for guidance on appropriate first aid. Where medical attention is required, ensure to bring along MSDS(s) of chemical(s) to aid medical staff in proper diagnosis and treatment.

Area: Carefully clean work area after use. Decontamination procedures vary depending on the material being handled.

#9	Designated Area

For irritants that are also considered particularly hazardous substances, a designated area shall be established per other applicable SOPs.

INCOMPATIBILITY OF COMMON LABORATORY CHEMICALS

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

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

Before mixing any chemicals, refer to this partial list and the chemicals' MSDS's

CHEMICAL	INCOMPATIBLE CHEMICAL(S)
Acetic acid	aldehyde, bases, carbonates, hydroxides, metals, oxidizers, peroxides, phosphates, xylene
Acetylene	halogens (chlorine, fluorine, etc.), mercury, potassium, oxidizers, silver
Acetone	acids, amines, oxidizers, plastics
Alkali and alkaline earth metals	acids, chromium, ethylene, halogens, hydrogen, mercury, nitrogen, oxidizers, plastics, sodium chloride, sulfur
Ammonia	acids, aldehydes, amides, halogens, heavy metals, oxidizers, plastics, sulfur
Ammonium nitrate	acids, alkalis, chloride salts, combustible materials, metals, organic materials, phosphorous, reducing agents, urea

Aniline	acids, aluminum, dibenzoyl peroxide, oxidizers, plastics
Azides	acids, heavy metals, oxidizers
Bromine	acetaldehyde, alcohols, alkalis, amines, combustible materials, ethylene, fluorine, hydrogen, ketones (acetone, carbonyls, etc.), metals, sulfur
Calcium oxide	acids, ethanol, fluorine, organic materials
Carbon (activated)	alkali metals, calcium hypochlorite, halogens, oxidizers
Carbon tetrachloride	benzoyl peroxide, ethylene, fluorine, metals, oxygen, plastics, silanes
Chlorates	powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid	acetone, alcohols, alkalis, ammonia, bases
Chromium trioxide	benzene, combustible materials, hydrocarbons, metals, organic materials, phosphorous, plastics
Chlorine	alcohol's, ammonia, benzene, combustible materials, flammable compounds (hydrazine), hydrocarbons (acetylene, ethylene, etc.), hydrogen peroxide, iodine, metals, nitrogen, oxygen, sodium hydroxide
Chlorine dioxide	hydrogen, mercury, organic materials, phosphorous, potassium hydroxide, sulfur
Copper	calcium, hydrocarbons, oxidizers
Hydroperoxide	reducing agents
Cyanides	acids, alkaloids, aluminum, iodine, oxidizers, strong bases
Flammable liquids	ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	alcohol's, aldehydes, ammonia, combustible materials, halocarbons, halogens, hydrocarbons, ketones, metals, organic acids
Hydrocarbons (Such as butane, propane benzene, turpentine, etc.)	acids, bases, oxidizers, plastics
Hydrofluoric acid	metals, organic materials, plastics, silica (glass), (anhydrous) sodium
Hydrogen peroxide	acetylaldehyde, acetic acid, acetone, alcohol's carboxylic acid, combustible materials, metals, nitric acid, organic compounds, phosphorous, sulfuric acid, sodium, aniline
Hydrogen sulfide	acetylaldehyde, metals, oxidizers, sodium
Hypochlorites	acids, activated carbon
Iodine	acetylaldehyde, acetylene, ammonia, metals, sodium

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

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

Common Lab Oxidizers:

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

Flammable and Combustible Materials

Materials that are flammable or combustible can burn or ignite causing fire or other heat giving reactions.

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

	Flash Point*	**Boiling Point**
Flammable		
ClassIA	< 73°F (22.8°C)	< 100°F (37.8°C)
Class IB	< 73°F (22.8°C)	≥100°F (37.8°C)
Class IC	≥73°F (22.8°C) <100°F (37.8°C)	

Combustible

Class II ≥100°F (37.8°C)&< 140°F (60°C)

Class IIA ≥140°F (60°C)&< 200°F (93°C)

Class IIIB ≥200°F (93°C)

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

How do I handle flammable and combustible materials?

When handling these materials you should always:

- Eliminate ignition sources such as open flames, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity
- Assure appropriate fire extinguishers and/or sprinkler systems are in the area
- Ensure there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drum. Assure bonding and grounding is checked periodically
- Do not heat flammable liquids with an open flame. Steam baths, salt and sand baths, oil and wax baths, heating mantles and hot air or nitrogen baths are preferable.
- Minimize the production of vapors and the associated risk of ignition by flashback. Vapors from flammable liquids are denser than air and tend to sink to the floor level where they can spread over a large area.
- No storage of flammable chemicals in container sizes greater than 1 gallon will be permitted in labs unless: a) The flammable chemicals are stored in a flammable storage cabinet or b) The flammable chemicals are stored in an approved flammable safety can.

Examples of Flammable Materials:

Chemical	Flash Point		Boiling Point		NFPA Class
	° F	° C	° F	° C	
Acetaldehyde	-38	-39	69	21	IA
Dimethyl sulfide	-36	-38	99	37	IA
Ethyl ether	-49	-45	95	35	IA
Ethylene oxide	-20	-29	55	13	IA
Pentane	-57	-49	97	36	IA

Propane	-157	-105	-44	-42	IA
Benzene	12	-11	176	80	IB
Carbon disulfide	-22	-30	115	46	IB
Cyclohexane	-4	-20	179	81	IB
Ethyl alcohol	55	13	173	78	IB
n-Hexane	-7	-22	156	69	IB
Methyl alcohol	52	11	149	65	IB
Methyl ethyl ketone	16	-9	176	80	IB
Pyridine	68	20	239-241	116	IB
Tetrahydrofuran	6	-14	153	67	IB
Toluene	40	4	231	111	IB
Triethylamine	20	-7	193	89	IB
tert Butyl isocyanate	80	27	185-187	85-86	IC
Chlorobenzene	82	28	270	132	IC
Epichlorohydrin	88	31	239-243	115-117	IC
2-Nitropropane	75	24	248	120	IC
Xylene	81-90	27-32	280-291	138-144	IC
Acetic Acid, glacial	103	39	244	48	II
Bromobenzene	118	48	307-316	153-158	II
Formic Acid	156	69	213	101	II
Morpholine	100	38	263	128	II
Stoddard Solvent	100-140	38-60	300-400	150-200	II
Benzaldehyde	145	63	352	178	IIIA
Cyclohexanol	154	68	322	161	IIIA
Methacrylic Acid	170	77	316	158	IIIA
Nitrobenzene	190	88	412	211	IIIA
Tetrahydronaphthalene	160	71	406	208	IIIA
Benzyl Alcohol	213	101	401	205	IIIB
Caproic Acid	215	102	400	204	IIIB

Ethylene Glycol	232	111	388	198	IIIB
Phenyl Ether	239	115	498	258	IIIB
Stearic Acid	385	196	726	386	IIIB

Compressed Gases

What are the risks of compressed gases?

Gases can be toxic, flammable, corrosive or inert which poses risk of many possible hazards such as fire, asphyxiation, chemical burns or poisoning. These gases are also under high pressure which if handled improperly can be propelled or whipped around causing potential harm.

What do I do when handling compressed gases?

- Determine if the gas being handled is toxic, flammable, or hazardous in anyway and act accordingly
- Avoid dropping, dragging or banging the cylinders containing compressed gas
- Never tamper with pressure release valves
- Use only in well ventilated areas
- Never open a cylinder valve unless the regulator is completely closed.
- Keep sources of ignition away from containers

How do I properly store compressed gases?

- Make sure all containers are properly labeled before storage
- Use racks, straps or chains to secure the containers upright
- Store in an area that will not be heated by sunlight, radiators, machines or anything else that may release heat
- Never carry or walk cylinders by hand

APSU Chemical Hygiene Plan Section 6: Lab Safety Practices

This section includes definitions and abbreviations used throughout this binder, defines the scope and application of the CHP regulation, and provides a basic overview of lab safety. Please read this entire section.

6.1 Definitions and Abbreviations

Definitions:

Carcinogen (*see select carcinogen*).

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

Chemical Hygiene Plan: a formal document developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements set forth by OSHA.

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

Compressed gas:
(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or
(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or
(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

Designated area: an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may also be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

Emergency: any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee: an individual employed in a laboratory workplace that may be exposed to hazardous chemicals in the course of his or her assignments.

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

Flammable: a chemical that falls into one of the following categories:
(i) *Aerosol, flammable*: an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

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

(iii) *Liquid, flammable*: any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) *Solid, flammable*: a solid, other than a blasting agent or explosive as defined in 29 CFR 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint: the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:
(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or
(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or
(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).
Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical: a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants,

corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

Laboratory: a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory scale: work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood: a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.
Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals: handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"
(ii) Multiple chemical procedures or chemicals are used;
(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and
(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Medical consultation: a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

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 has been replaced by an organic radical.

Oxidizer: a chemical other than a blasting agent or explosive as defined in (OSHA) 29 CFR 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

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

Protective laboratory practices and equipment: those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive toxins: chemicals which affect the reproductive health of women or men or the ability of couples to have healthy children. These effects can include chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen: any substance which meets one of the following criteria:
(i) It is regulated by OSHA as a carcinogen; or
(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or
(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or
(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;
(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or
(C) After oral dosages of less than 50 mg/kg of body weight per day.

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

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

Abbreviations:
CHO – Chemical Hygiene Officer
CHP – Chemical Hygiene Plan
MSDS – Material Safety Data Sheet
NIOSH – National Institute for Occupational Safety and Health
OSHA – Occupational Safety and Health Administration
PPE – Personal Protective Equipment
SOP – Standard Operating Procedure

6.2 Application of CHP requirements

The OSHA lab standard applies where "laboratory use" of hazardous chemicals occurs. Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

• The handling or use of chemicals occurs on a "laboratory scale"; that is, the work involves containers which can easily and safely be manipulated by one person,
• Multiple chemical procedures or chemical substances are used, and
• Protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposures to hazardous chemicals.

At a minimum, this definition covers employees (including student employees, technicians, supervisors, lead researchers and physicians) who use chemicals in teaching, research and clinical laboratories at Austin Peay State University.
Where the use of hazardous chemicals provides no potential for employee exposure, such as in procedures using chemically impregnated test media and commercially prepared test kits, a CHP is not required.

6.3 Coordination with Other Regulations and Procedures

Although this standard deals only with use of hazardous chemicals, employees may also encounter potential physical, biological or radioactive hazards in the laboratory. In addition, other campus policies and procedures affect the use of hazardous chemicals. For example, the procedures for Hazardous Waste Management describe the proper process for the disposal of laboratory chemicals. In the event that there is a conflict between provisions of various policies, contact APSU EHS at 6103 or 7456 for assistance in resolving the discrepancy.

6.4 Employee Information and Training

It is essential that laboratory employees have access to information on the hazards of chemicals and on proper procedures for working safely. Supervisors must ensure that laboratory employees are informed about and have access to the following information sources (NOTE – access to the OSHA regulations can be in the form of on-line browsing, provided that the employee has computer access and an opportunity to view the information during work hours):

• The contents of the OSHA lab standard, Occupational Exposure to Hazardous
Chemicals in Laboratories, and its appendices (29 CFR 1910.1450 – available on-line at www.osha.gov under the Laws and Regulations link)
• Austin Peay State University guidance for Chemical Hygiene Plans
• The Permissible Exposure Limits (PEL) for OSHA regulated substances (29 CFR 1910.1000 – available on-line at www.osha.gov under the Laws and Regulations link)
• Safety data sheets (MSDS) for laboratory chemicals. The MSDS provides information on hazards, safe handling practices, and symptoms of exposure for commercially sold products. MSDSs are available from MSDS Online via Onestop, in individual laboratory collections, and from the manufacturer.

Each laboratory supervisor is responsible for ensuring that laboratory employees are provided with training about the hazards of chemicals present in their laboratory work area, and methods to control exposure to such chemicals. Each employee shall receive training at the time of initial assignment to the laboratory and prior to assignments involving new exposure situations. Refresher training shall be conducted at least annually. Training must be documented, for

example with a training sign-in sheet that includes an outline of the material covered. Employee training must be recorded and kept in the laboratory file for five years.

Training materials may include any of the following:
• Literature describing proper lab practices (such as using this document or MSDS reviews)
• Video libraries
• Group and individual training conducted by lab personnel or APSU EHS staff
• On-Line laboratory safety modules

Employee training programs must include, at a minimum, the following subjects:
• Methods of detecting the presence of hazardous chemicals (observation, signage and labeling, odor, real-time monitoring, air sampling, etc.)
• Symptoms associated with exposures, and the physical and health hazards of the chemicals in the work area
• Good laboratory practice, including general techniques designed to reduce personal exposure and to control physical hazards, as well as specific protective mechanisms and warning systems used in individual laboratories
• Emergency response actions appropriate to individual laboratories
• Applicable details of the Chemical Hygiene Plan, including general and laboratory specific Standard Operating Procedures
• Proper procedures for handling, labeling, and storing chemical waste**,** generated by laboratory operations

6.5 Laboratory Door Signs

Door hazard warning signs provide an overview of the hazards in the laboratory, and also serve as a quick reference for the names and phone numbers of both laboratory management and emergency contact personnel. Each laboratory must have up-to-date door signage that includes names and phone numbers for personnel managing that laboratory who are familiar with the content and workings of the lab. Note: 911 is NOT a legitimate emergency contact number. The door sign must also include a summary of the key hazards in the laboratory. The contact phone numbers on the door are critical in the event of an emergency involving the laboratory. Keep this information current and accurate. Door signage must be reviewed annually and whenever there are personnel changes. For help printing or laminating door signs, contact APSU EHS.

6.6 Annual Chemical Hygiene Plan Review
The laboratory supervisor and Chemical Hygiene Officer (CHO) will review the laboratory's Chemical Hygiene Plan annually. The review must be documented, such as with the date and initials of the reviewer on the front of the CHP. The CHO is responsible for assigning responsibility for taking corrective action for any deficiency noted. During the annual CHP review, the laboratory door sign will also be reviewed to ensure the contact names and phone numbers are still accurate, and that the hazard signage is still appropriate for the chemicals and activities in the laboratory.

6.7 Eye Washes, Safety Showers and Fire Extinguishers
Any laboratory working with toxic or corrosive chemicals must have an easily accessible eye wash. Eye washes must be flushed regularly by the user to ensure that they are working, and that

the water is clean, should emergency use become necessary. Ideally these eye wash checks should be performed weekly, and no less frequently than monthly, and must be documented (date and initials). Report malfunctions in the eyewash to the Physical Plant for repairs.
Safety showers are tested monthly by EHS. Fire extinguishers are also checked monthly by APSU EHS.

6.8 Standard Procedures for Working in the Laboratory

The following are generally accepted practices for use of chemicals in particular situations.
They can be overridden in specific instances when appropriate. It is advisable to document the reasons for such modifications.

Controlling Chemical Exposure

Each laboratory employee shall minimize personal and coworker exposure to the chemicals in the laboratory. General precautions which shall be followed to achieve this goal during the handling and use of all chemicals are as follows:

- A chemical mixture shall be assumed to be as toxic as its most toxic component. Possibilities for substitution will be investigated.
- Laboratory employees shall be familiar with the symptoms of exposure for the chemicals with which they work and the precautions necessary to prevent exposure.
- Label all chemicals to identify the container contents and appropriate hazard warnings.
- Recap bottles tightly (but do not over-tighten or the cap may break), and clean any residue off the outside of the bottle. Loose caps and drips on the outside of the bottle create unexpected chemical exposures.
- Eating, drinking, and smoking is prohibited in areas where laboratory chemicals are present. Thoroughly wash hands after handling chemicals. Storage, handling and consumption of food or beverages shall not occur in chemical storage areas, nor with glassware or utensils also used for laboratory operations.
- Refrigerators used to store reagents and samples cannot be used to store food and drinks for human consumption. Ensure that they are clearly labeled to indicate their function such as with signage that says either “No food or drink” or “For Food Only.”
- Ice from a laboratory ice machine is not to be used for human consumption.
- Each employee shall keep the work area clean and uncluttered (clutter “…shall not interfere with safe work operations” per Tennessee OSHA). At the completion of each work day or operation, the work area shall be cleaned.
- Hallways, corridors, and exit ways must be kept clear. Do not allow equipment to block the exit pathway (even temporarily).
- Mouth suction for pipetting or starting a siphon is prohibited.
- Skin contact with all chemicals shall be avoided. Employees shall wash exposed skin prior to leaving the laboratory.
- Additional specific precautions based on the toxicological characteristics of individual chemicals shall be implemented as deemed necessary by the lab supervisor.

Safe Handling Guidelines

Treat chemicals with caution and respect by following these guidelines:

- Use only the amount of chemical needed for the immediate task at hand.

- Properly seal, label, and store chemicals in appropriate containers. Keep the containers clearly marked and in a well-ventilated area.
- Learn how to dispose of chemicals safely and legally.
- Clean up spills and leaks immediately.
- Know what to do in an emergency.
- Do not transport unprotected chemicals between the work area and other areas. Use a tray, rack, cart, or rubber carrier. Always use a secondary container when transporting hazardous or highly odorous chemicals on an elevator.

Chemical Purchasing and Storage

- Buy the smallest quantity needed for use in the near future. Large quantities increase the spill and hazard potential, take up valuable space in chemical storage areas, and require on-going effort to properly store and inventory. Additionally, excess chemicals that become unusable due to deterioration and age cost additional expense for disposal as hazardous waste.
- Less concentrated chemicals generally are less hazardous, so purchasing the least concentrated form necessary reduces the hazard potential.
- Some chemicals are available as a concentrated powder or in a dilute liquid form. The powder form is a greater hazard both as an inhalation risk and for contamination of the work area. For example, ethidium bromide in a powder form presents a much greater hazard potential than the liquid suspension. Whenever possible avoid purchasing concentrated powders to minimize exposure potential during weighing and from spills.
- Initial and date the label on all new chemicals. This lets other people in the lab know who is responsible for the item, and provides valuable information for long term chemical management.
- Whenever possible, substitute less hazardous chemicals into a procedure.

Storage guidelines

- Proper chemical storage is as important to safety as proper chemical handling. Often, seemingly logical storage ideas, such as placing chemicals in alphabetical order, may cause incompatible chemicals to be stored together.
- Read chemical labels and MSDSs for specific storage instructions.
- Store chemicals in a well-ventilated area; however, do **not** routinely store chemicals in a fume hood (they block airflow, and impair proper usage of the hood).
- Return chemical containers to their proper storage location after use.
- Check stored chemical supplies for deteriorated chemicals and broken containers.
- Do not store chemicals near heat or in direct sunlight.
- Do not store flammable materials near electrical sources.
- Store corrosive and reactive chemicals in secondary containment trays.
- Store glass chemical containers so that they are unlikely to be broken.
- Whenever possible store hazardous chemicals below eye level.
- Never store hazardous chemicals in a public area or corridor.

6.9 Laboratory Equipment Overview

- The following rules shall apply to the use of laboratory equipment:
- All laboratory equipment shall be used properly and only for its **intended purpose**.
- All laboratory equipment shall be **inspected** on a periodic basis and receive maintenance, repair or replacement as necessary.

- Do not defeat, remove, or override equipment safety devices.
- IMPORTANT: Disconnect any equipment that is unsafe or does not work properly and remove it from service. Notify other users of the problem.

Laboratory Equipment – Aerosol Production

The term “aerosol” refers to liquid or solid particles suspended in air. These can pose a serious risk because small aerosols readily penetrate and remain deep in the respiratory tract, they can remain suspended in the air for long period of time, and they easily contaminate equipment and ventilation systems. The following equipment may produce aerosols:

- Centrifuge
- Blender
- Shaker
- Magnetic stirrer
- Sonicator
- Pipet
- Vortex mixer
- Syringe and needle
- Grinder, mortar and pestle
- Separatory funnel

Follow these guidelines to eliminate or reduce the hazards associated with aerosols:

- Conduct procedures that may produce aerosols in a biological safety cabinet or a chemical fume hood, as appropriate.
- Keep tubes stoppered when vortexing or centrifuging.
- Allow aerosols to settle for one to five minutes before opening a centrifuge, blender or tube.
- When combining liquids, discharge the secondary material down the side of the container or as close to the surface so the primary liquid as possible.
- Use a mechanical pipetting device.

Laboratory Equipment – Centrifuges

Centrifuging presents the possibility of two serious hazards: mechanical failure and aerosols. The most common hazard associated with centrifuging is a broken tube. To ensure safety when operating a centrifuge, take precautions to ensure the following:

- Proper loading (accurate balancing)
- Safe operating speeds (do not exceed manufacturing recommendations)
- Safe stopping
- Complete removal of materials
- Proper cleanup
- Follow these guidelines when working with a centrifuge:
- When loading the rotor, examine the tubes for signs of stress and discard any tubes that are damaged.
- Inspect the inside of each tube cavity or bucket. Remove any glass or other debris from the rubber cushion.
- Ensure that the centrifuge has adequate shielding to guard against accidental 'fly-aways'.
- Use a centrifuge only if it has a disconnect switch that deactivates the rotor when the lid is open.

- Always keep the lid closed during operations and shut down. Do not open the lid until the rotor is completely stopped.
- Do not break the head rotation by hand.
- Do not use aluminum foil to cap a centrifuge tube. Foil may rupture or detach.
- When balancing the rotors, consider the tubes, buckets, adapters, inserts and any added solution.
- Stop the rotor and discontinue operation if you notice anything abnormal such as a noise or vibration.
- Rotor heads, buckets, adapters, tubes and plastic inserts must match.

High-speed centrifuges pose additional hazards due to the higher stress and force applied to their rotors and tubes. In addition to the safety guidelines outlined above, follow these guidelines for high-speed centrifuges:

• Filter the air exhausted from the vacuum lines.
• Keep a record of rotor usage in order to avoid the hazard of metal fatigue.
• Frequently inspect, clean and dry rotors to prevent corrosion or other damage**.**
• Follow the manufacturers operating instructions exactly.

Laboratory Equipment – Compressed Gases

IMPORTANT: Cylinders that are knocked over or dropped can be very dangerous and can cause serious injuries. If a valve is knocked off a compressed gas cylinder, the cylinder can become a lethal projectile. *Damaged cylinders can travel through walls much like a torpedo travels through water. They can cause structural damage, severe injury and death.*

Follow these guidelines to ensure safe storage of gas cylinders:

- Secure all cylinders in racks, holders, or clamping devices in a well-ventilated area.
- Do not rely on color to identify container contents. Check the label.
- Close valves, and release pressure on the regulators when cylinders are not in use.
- Minimize the number of hazardous gas cylinders in a laboratory.
- Keep heat, sparks, flames and electrical circuits away from gas cylinders.
- Store cylinders of oxygen and other oxidizing agents at least 20 feet from flammable gas cylinders, or separate these items with a fire wall at least five-feet high, having a fire resistance rating of at least 0.5 hour.
- Do not store gas cylinders in exit or egress routes, hallways or public areas.

- When working with compressed gas cylinders, remember the following:
- Never move a gas cylinder unless the cylinder cap is in place and the cylinder is chained or otherwise secured to a cart.
- Wear sturdy shoes (no open-toed, sandals, etc.) when moving or transporting cylinders.
- Do not move a cylinder by rolling it on its base.
- Only use regulators approved for the type of gas in the cylinder.
- Do not use adapters to interchange regulators.
- When opening a cylinder valve, follow these guidelines:
- Direct the cylinder opening and the valve faceplate away from people and open the valve slowly.
- If an inert gas cylinder leaks, carefully move the cylinder to an open space outdoors (if it is safe to move the cylinder). Have the supplier pick up the cylinder.

- If a flammable or oxidizing gas cylinder leaks, move the cylinder to the hood, shut off all ignition sources, pull the fire alarm, and evacuate the area. When firefighters arrive, meet them and tell them the situation. Once the situation is stabilized, call the supplier to replace the cylinder (if it is rented).
- If a poison gas leaks, move the cylinder to a hood (if it is not already there), pull the fire alarm, and evacuate the area. When firefighters arrive, meet them and tell them the situation. Once the situation is stabilized, call the supplier to replace the cylinder (if it is rented).
- Do not use oil or other lubricant on valves and fittings.
- Do not use oxygen as a substitute for compressed air.
- Do not lift cylinders by the cap.
- Do not tamper with the safety devices on a cylinder. Have the manufacturer or supplier handle cylinder repairs.
- Do not change a cylinder's label or color. Do not refill cylinders yourself.
- Do not heat cylinders to raise internal pressure.
- Do not use compressed gas to clean your skin or clothing.
- Do not completely empty cylinders. Maintain at least 30 psi.
- Do not use copper (or use <65% copper alloy) connectors or tubing with acetylene. Acetylene can form explosive compounds with silver, copper and mercury.
- Always wear impact resistant glasses or goggles when working with compressed gases.

Laboratory Equipment – Cryogenic Fluids

Cryogenic fluids, such as liquid air, liquid nitrogen or liquid oxygen are used to obtain extremely cold temperatures. Most cryogenic liquids are odorless, colorless and tasteless when vaporized. When cryogenic liquids are exposed to the atmosphere, however, they create a highly visible and dense fog. All cryogens other than oxygen can displace breathable air and can cause asphyxiation. Cryogens can also cause frostbite on exposed skin and eye tissue.

Cryogens pose numerous hazards. For example, cryogenic vapors from liquid oxygen or liquid hydrogen may cause a fire or explosion if ignited. Materials that are normally noncombustible (e.g., carbon steel) may ignite if coated with an oxygen-rich condensate. Liquefied inert gases, such as liquid nitrogen or liquid helium, are capable of condensing atmospheric oxygen and causing oxygen entrapment or enrichment in unsuspected areas. Extremely cold metal surfaces are also capable of entrapping atmospheric oxygen. Because the low temperatures of cryogenic liquids may affect material properties, take care to select equipment materials accordingly.

Follow these guidelines when working with cryogenic liquids:

- Before working with cryogenic liquids, acquire a thorough knowledge of cryogenic procedures, equipment operation, safety devices, material properties, protective equipment usage.
- Keep equipment and systems extremely clean.
- Avoid skin and eye contact with cryogenic liquids. Do not inhale cryogenic vapors.
- Never touch a dispensing nozzle *barehanded* after dispensing has begun.
- Pre-cool receiving vessels to avoid thermal shock and splashing.
- Use tongs to place and remove items in cryogenic liquid.
- When discharging cryogenic liquids, purge the line slowly. Only use transfer lines specifically designed for cryogenic liquids. Liquid nitrogen boils and spews out of containers (such as Thermo-Flasks or mortars) when room temperature objects are inserted. Avoid flying droplets!

- Rubber and plastic may become very brittle in extreme cold. Handle these items carefully when removing them from cryogenic liquid.
- Store cryogenic liquids in double-walled, insulated containers (e.g., Dewar flasks.)
- To protect yourself from broken glass if the container breaks or implodes, tape the exposed glass on cryogenic containers.
- Do not seal a container until it comes to ambient temperature. Sealed containers containing cryogenic samples may implode as the air space rapidly cools, or explode as the sample comes to room temperature.
- DO NOT pour excess cryogenic liquid down the drain! The plumbing will freeze and break.
- Do not store cylinders of cryogenic liquids in hallways or other public areas.
- **IMPORTANT:** Be aware of the tremendous expansion and displacement of oxygen when a cryogenic liquid vaporizes at room temperature.

Laboratory Equipment – Electrophoresis

Electrophoresis equipment may be a major source of electrical hazard in the laboratory. The presence of high voltage and conductive fluid in this apparatus presents a potentially lethal combination. Many people are unaware of the hazards associated with this apparatus; even a standard electrophoresis operating at 100 volts can deliver a lethal shock at 25 milliamps. In addition, even a slight leak in the device tank can result in a serious shock. Protect yourself from the hazards of electrophoresis and electrical shock by taking these precautions:

- Use physical barriers to prevent inadvertent contact with the apparatus.
- Use electrical interlocks.
- Frequently check the physical integrity of the electrophoresis equipment.
- Use warning signs to alert others of the potential electrical hazard.
- Use only insulated lead connectors.
- Turn the power off before connecting the electrical leads.
- Connect one lead at a time using one hand only.
- Ensure that your hands are dry when connecting the leads.
- Keep the apparatus away from water and water sources.
- Turn the power off before opening the lid or reaching into the chamber.
- Do not disable safety devices.
- Follow the equipment operating instructions.

Laboratory Equipment – UV Light Tables

UV or ultraviolet lamps are used in biological safety cabinets, light boxes, and cross linkers in many university laboratories. One of the problems in working with UV radiation is that the symptoms of overexposure are not immediately felt so that persons exposed do not realize the hazard until after the damage is done.

UV radiation is that radiation just outside the visible range, or under 400 nanometers (nm). A University lab employee received skin and eye burns while using an acrylic plastic shield for protection against UV. The lab did not realize that the shield had not been manufactured for this use and was not rated for protection against UV light. Please check your safety equipment to ensure that it is rated for the wavelength in use. The health effects of exposure to UV light are familiar to anyone who has had sunburn. However, the UV light levels around some UV equipment greatly exceed the levels found in nature. Acute (short-term) effects include redness or ulceration of the skin. At high levels of exposure, these burns can be serious.

For chronic exposures, there is also a cumulative risk of harm. This risk depends upon the amount of exposure during your lifetime. The long-term risk for large cumulative exposure includes premature aging of the skin and even skin cancer. UV exposure is not immediately felt, so the user may not realize a hazard until after the damage is done. The eyes are also susceptible to UV damage. Like the skin, the covering of the eye or the cornea, is epithelial tissue, too.

The danger to the eye is enhanced by the fact that light can enter from all angles around the eye and not only the direction you are looking in. The lens can also be damaged, but since the cornea acts as a filter, the chances are reduced. This should not lessen the concern over lens damage however, because cataracts are the direct result of lens damage. Burns to the eyes are usually more painful and serious than a burn to the skin. Make sure your eye protection is appropriate for this work. There are specially-made safety glasses for the different UV ranges.

NORMAL EYEGLASSES OR CONTACTS OFFER VERY LIMITED PROTECTION!!
Do not forget to protect the rest of the face. Severe skin burns can happen in a very short time, especially under your chin (where most people forget to cover). Full-face shields are really the only appropriate protection when working with UV light boxes for more than a few seconds.
Be sure to protect your arms and hands by wearing a long-sleeve lab coat and gloves.

Laboratory Equipment – Glassware

Accidents involving glassware are the leading cause of laboratory injuries. To reduce the chance of cuts or punctures, use common sense when working with glassware. In addition, follow special safety precautions for tasks that involve unusual risks. Follow these practices for using laboratory glassware safely:

- Prevent damage to glassware during handling and storage.
- Inspect glassware before and after each use. Discard or repair any cracked, broken or damaged glassware in a sturdy container.
- Thoroughly clean and decontaminate glassware after each use.
- When inserting glass tubing into rubber stoppers or corks, follow these guidelines:
    a) use adequate hand protection
    b) lubricate the tubing
    c) hold hands close together to minimize movement if the glass breaks
- When possible, substitute plastic or metal connectors for glass connectors.
- Large glass containers are highly susceptible to thermal shock. Heat and cool large glass containers slowly.
- Use Pyrex or heat-treated glass for heating operations.
- Leave at least 10 percent air space in containers with positive closure.
- Never use laboratory glassware for vacuum operation.
- Use round-bottomed glassware for vacuum operations. Flat-bottomed glassware is not as strong as round-bottomed glassware.

NOTE: If not absolutely necessary, do not use chromic acid to clean glassware. Use a standard laboratory detergent. Chromic acid is extremely corrosive and expensive to dispose of. Spent (green) Chromic acid solutions must always be collected for disposal as hazardous waste.

Follow these safety guidelines for handling glassware:

- When handling cool flasks, grasp the neck with one hand and support the bottom with the other hand.
- Lift cool beakers by grasping the sides just below the rim. For large beakers, use two hands: one on the side and one supporting the bottom.
- Never carry bottles by their necks.
- Use a cart to transport large bottles of dense liquid (e.g. a 4 liter bottle of Chloroform).
- Follow these guidelines for handling and disposing of broken glass:
- Do not pick up broken glass with bare or unprotected hands. Use a brush and dust pan to clean up broken glass. Remove broken glass in sinks by using tongs for large pieces and cotton held by tongs for small pieces and slivers.
- Glass contaminated with biological, chemical, or radioactive materials must be decontaminated before disposal or be disposed of as hazardous waste.
- Before disposing of broken glass in a trash can, place the glass in a rigid container such as cardboard and mark it "Broken Glass." To prevent accidental cuts and punctures to the housekeeping staff during trash disposal (as easily happens if the cardboard gets wet), the best option is to take collections of broken glass directly to the dumpster.

Laboratory Equipment – Heating Systems

Common hazards associated with laboratory heating devices include electrical hazards, fire hazards and hot surfaces. Some laboratory heating procedures involve an open flame. Devices that supply heat for reactions or separations include the following:

- Open flame burners
- Hot plates
- Heating mantles
- Oil and air baths
- Hot air guns
- Ovens
- Furnaces
- Ashing systems

IMPORTANT: Never leave an open flame unattended.

Follow these guidelines when using heating devices:

- Ensure that heating units have an automatic shutoff to protect against overheating.
- Ensure that heating devices and all connecting components are in good working condition.
- Heating baths should be equipped with timers to ensure that they turn on and off at appropriate times.
- Use a chemical fume hood when heating flammable or combustible solvents. Arrange the equipment so that escaping vapors do not contact heated or sparking surfaces.
- Use non-asbestos thermal-heat resistant gloves to handle heated materials and equipment.
- Perchloric acid digestions must be conducted in a functioning perchloric fume hood with an EH&S approved wash-down system.
- Minimize the use of open flames.
- Heated chemicals can cause more damage and more quickly than would the same chemicals at a lower temperature. RULE OF THUMB: Reaction rates double for each 10°C increase in temperature.

Laboratory Equipment – Pressurized Systems

Do not conduct a reaction in, or apply heat to, a closed system apparatus unless the equipment is designed and tested to withstand pressure. Pressurized systems should have an appropriate relief valve. Pressurized systems must be fully shielded and should not be conducted in an occupied space until safe operation has been assured. Until safe operation is assured, remote operation is mandatory.

Safety Points to Remember:

- Minimize risk and exposure
- Identify and assess all hazards and consequences
- Use remote manipulations whenever possible
- Minimize pressure, volume and temperature
- Use material with a predictably safe failure mode
- Ensure that the components of the pressurized system will maintain structural integrity at the maximum allowable working pressure; avoid material that may become brittle.
- Operate within the original design parameters
- Provide backup protection (e.g., pressure relief valves, fail-safe devices)
- Use quality hardware
- Use protective shield or enclosures
- Use tie-downs to secure tubing and other equipment
- Do not leave a pressurized system unattended

IMPORTANT: Normally pressurized systems should not include glass components unless they are specially designed and intended for that purpose.

Laboratory Equipment – Vacuum Systems

Vacuum systems pose severe implosion hazards.

IMPORTANT: Conduct all vacuum operations behind a table shield or in a fume hood with the sash down. Follow these guidelines and requirements to ensure system safety:

- Ensure that pumps have belt guards in place during operation.
- Ensure that service cords and switches are free from defects.
- Always use a trap on vacuum lines to prevent liquids from being drawn into the pump, house vacuum line or water drain.
- Replace and properly dispose of vacuum pump oil that is contaminated with condensate.
- Used pump oil must be disposed as hazardous waste.
- Place a pan under pumps near containers of flammable chemicals.
- Do not place pumps in an enclosed, unventilated cabinet.

CAUTION: Do not underestimate the pressure differential across the walls of glassware that can be created by a water aspirator. The glassware used with vacuum operations must meet the following requirements:

- Only heavy-walled round-bottomed glassware should be used for vacuum operations.
- The only exception to this rule is glassware specifically designed for vacuum operations, such as an Erlenmeyer filtration flask.

- Wrap exposed glass with tape to prevent flying glass if an implosion occurs.
- Carefully inspect vacuum glassware before and after each use. Discard any glass that is chipped, scratched, broken or otherwise stressed.
- Glass desiccators often have a slight vacuum due to contents cooling. When using desiccators, follow these guidelines:
- When possible, use molded plastic desiccators with high tensile strength.
- For glass desiccators, use a perforated metal desiccator guard.

Laboratory Equipment – Refrigerators/Freezers

Household refrigerators must not be used to store flammable liquids, unless the flammable liquid container can be secondarily enclosed in a sealed container. Many flammable solvents are still volatile at refrigerator temperatures. The storage compartment of a household refrigerator contains ignition sources such as the thermostat and light. Additionally, the compressor and electrical circuits located at the bottom of the unit where chemical vapors are likely to accumulate are not sealed. This combination of flammable vapor and ignition source has created explosions in many university laboratories.

Laboratory-safe or explosion-proof refrigerators are required if large containers or volumes of flammable liquids must be refrigerated. In laboratory-safe refrigerators the sparking components are located on the exterior of the refrigerator. Explosion-proof refrigerators are required in areas that may contain high levels of flammable vapors (e.g., chemical storage rooms with large quantities of flammable chemicals).

Laboratory Equipment – Cold Traps

A cold trap is a condensing device used to prevent moisture contamination in a vacuum line. Guidelines for using a cold trap include:

- Locate the cold trap between the system and vacuum pump.
- Ensure that the cold trap is of sufficient size and cold enough to condense vapors present in the system.
- Check frequently for blockages in the cold trap.
- Use isopropanol/dry ice or ethanol/dry ice instead of acetone/dry ice to create a cold trap.
- Isopropanol and ethanol are cheaper, less toxic and less prone to foam.
- Do not use dry ice or liquefied gas refrigerant bath in a closed system. These can create uncontrolled and dangerously high pressures.

Laboratory Equipment – Mercury Containing Devices and Thermometers

Mercury thermometers and mercury-containing devices are a major source of contamination from spills, leaks and breaks. Contamination is easily spread and often expensive to clean up. This is in addition to the usual high cost of disposal. Therefore, the use of mercury containing devices must be phased out as much as practicable. Here are a few ways to better manage mercury containing devices:

- Collect and submit to hazardous waste collection any unwanted mercury thermometers.
- Dispose of any mercury spill cleanup debris as hazardous waste.

- Replace mercury thermometers with alcohol thermometers (blue and red types are alcohol thermometers) whenever possible.
- Dispose of mercury containing items through EHS (these include manometers, some blood pressure cuffs, mercury switches, and thermometers). Always double-bag mercury containing items.
- Do not take mercury containing devices to surplus/salvage unless the mercury has first been removed.
- Do not accumulate more mercury thermometers than you need.
- If precision work is being done that necessitates a mercury thermometer, buy a Teflon coated thermometer. The added cost is easily offset compared against the inconvenience and money spent cleaning up broken thermometers.

APSU Chemical Hygiene Plan Section 7: HAZARD COMMUNICATION

PI / Laboratory Supervisors must inform laboratory personnel of the location and availability of the following information:

- OSHA Hazard Communication Standard, 1910.1200
- OSHA Occupational Exposure to Hazardous Chemicals in Laboratories Standard, 1910.1450
- Departmental Chemical Hygiene Plan
- Safety Data Sheets, including Permissible Exposure Limits (PEL) for chemicals
- APSU Hazard Communication Written Program

7.1 MSDS Online: Instructions for faculty, staff, and students at APSU

1. Login to your Onestop account.
2. Click on the "LIFE" tab at the top of the page.
3. Scroll to the bottom of the LIFE page. The MSDS Online link is on the bottom left.
4. Click on the link. You can search by product name, manufacturer, CAS#, etc. You can also narrow your search by building.

*If you need assistance finding an MSDS please contact EHS at 6103 or the Physical Plant at 7456.

7.2 APSU Hazard Communication Program

The university hazard communication program defines the parameters required by the OSHA Hazard Communication standard. The written program follows this section in the CHP binder.

APSU Chemical Hygiene Plan Section 8: Hazardous Waste and Spills

8.1 Hazardous Waste Management

8.1.1 Identification

The first step in appropriately managing hazardous waste is to determine if you have a hazardous waste. Before something can be a hazardous waste, it must be a waste. A waste is defined by the EPA as discarded material, inherently waste-like material, speculative accumulation, and use constituting disposal. How do you know if something is a waste?

Consider the following:

(1) Is it in good condition and labeled appropriately?

(2) Is it currently legal for use in the U.S.?

(3) Has anyone used it in the last 2 or 3 years?

(4) Will anyone use it in the next 2 or 3 years?

If you answered yes to all 4 questions, then you do not have a waste nor a hazardous waste.

A Hazardous waste can be a solid, liquid, gas, or sludge that meets the definition of a characteristic or listed hazardous waste. The following categories are not hazardous waste: Sewage, Radioactive Waste, Regular Trash, and Biological Waste.

Characteristic Hazardous Wastes
Waste solids, liquids, containerized gases, or sludges that exhibit any of the following characteristics are defined as characteristic hazardous wastes:

1) Ignitability - a flash point < 140 degrees Fahrenheit.

2) Corrosivity – Having a pH < 2 or > 12.5.

3) Reactivity – Water-reactive, pyrophoric, shock sensitive, generates sulfides or cyanides.

4) Toxicity – Specific listed chemicals including Arsenic, Benzene Cadmium, Tetrachloroethylene, Silver, etc.

Much of this information can be found on the Material Safety Data Sheet (MSDS).

Listed Hazardous Wastes
The USEPA has already predetermined that certain wastes are hazardous, and these hazardous wastes have been incorporated into published lists.

The “EPA Codes by Chemical Name” document on the APSU EHS website is a useful resource for looking up listed Hazardous Wastes.

- K-Listed Hazardous Wastes: K-listed hazardous wastes are source-specific wastes that are generated by specific industries such as iron and steel production facilities. K-listed hazardous wastes are not likely to be found in a laboratory.
- F-Listed Hazardous Wastes: F-listed hazardous wastes are non-specific source wastes that are generated by particular industrial processes that can occur in various industries. Industrial processes that generate F-listed hazardous wastes include wood preservation, electroplating and other metal finishing processes, and processes that generate waste solvents.
- P- and U-Listed Hazardous Wastes: The P- and U-listed hazardous wastes are pure and commercial grade formulations of specific unused chemicals that are considered wastes. Unused chemicals may be considered wastes because they are no longer needed, they are spilled, or they are off-specification. A complete list of the P & U listed wastes may be found on EPA's website here.

Acutely Toxic Hazardous Wastes
Certain listed hazardous wastes are considered to be acutely toxic to human health and the environment and are further defined as "acute hazardous wastes." Acute hazardous wastes include F-, K-, and P-listed hazardous wastes described above.

Listed Hazardous Wastes in Laboratories
P- and U-listed hazardous wastes are the most likely listed hazardous wastes to be found in laboratories.

Also, spilled chemicals and absorbent materials used to clean the spill should be disposed of as hazardous waste. Please note that the term "chemical" includes items containing chemicals such as acrylamide gels, paints, solvents, degreasers, glues, varnishes, and disinfectants, in addition to stock chemicals and chemical solutions used in laboratory processes.

8.1.2 Storage

Once a hazardous waste has been identified, it must be managed in accordance with local, state, and federal requirements.

- Make sure incompatible materials are separated.
- Contents must be compatible with container.
- Do not store waste in active hoods.
- Waste containers must have secondary containment. A shallow tray may suffice. The secondary containment must be able to hold 110% of the volume of the largest waste container.
- Containers must be closed AT ALL TIMES unless waste is being added to the container.

8.1.3 Labeling and Signage

- Every waste container must have a Hazardous Waste label. See the APSU EHS website for the label template. The hazardous waste label may be printed on Avery 6878 labels or printed on cardstock and tied on to the waste container with wire or a zip tie. Be sure to fill out all of the information on the label. Be sure to leave the Date Ended blank until the waste container is full.

- Every label must include the words “Hazardous Waste” and include a description of the contents.
- All waste accumulation areas must have a sign indicating that it is a Satellite Accumulation Area. A printable sign is available on the APSU EHS website.
- Every Satellite Accumulation Area sign must have an emergency contact listed with phone number.

8.1.4 Satellite Accumulation Areas

- Satellite Accumulation Area is the area (typically room) where the hazardous waste is generated.
- Can accumulate up to 55 gallons of hazardous waste or 1 quart of acutely hazardous waste.
- Must be designated with sign.

8.1.5 Disposal

When your hazardous waste container is full, complete the hazardous waste pickup form (available on the APSU EHS website) and submit it to the EHS Manager via e-mail or send form to the Physical Plant.

Empty containers can be placed in the general trash, except when it held an acutely hazardous waste. The containers should be defaced of any chemical or hazardous waste labels and the cap should be removed prior to disposal as regular trash. An empty container that has held an acute hazardous waste must be triple rinsed using a solvent (which might be water) capable of removing the acute hazardous waste prior to disposal of the container as regular trash. Each rinsing should be performed with an amount of solvent equal to approximately 5 percent of the volume of the container. The rinsate must be collected and disposed of as hazardous waste.

8.1.6 Contact Information

If you need help determining if a waste is a hazardous waste, contact the EHS Manager, Carl Gerhold at 6103 or e-mail gerholdc@apsu.edu.

8.2 Spills

Personnel should be trained and equipped to handle most small spills in their work areas. **The size of the spill and its hazards will guide the appropriate response.** If there is any doubt about a lab worker's ability to safely clean up the spill, call APSU EHS. Note that proper emergency response depends on understanding the hazards present in the lab. Do not attempt to clean a spill unless you are familiar with the hazards and safe handling of a chemical.

8.2.1 Preparation

To prepare for a potential spill, follow these guidelines:

- Have a chemical spill kit available, properly stocked, and make sure everyone in the lab knows the location
- Train all laboratory employees on how to use the spill kit
- Know how to turn off equipment, heat sources, electrical panels, etc.
- Know the routes of exposure and the hazards of the chemicals you work with, as well as the location of the MSDS

Clean contaminated equipment and spills immediately. Mercury from broken thermometers or other devices can create major contamination of equipment and environmental surfaces; clean mercury spills immediately.

8.2.2 Spill Response Kit

Work areas that contain hazardous chemicals must have a chemical spill response kit. This kit should include the following items:

- Disposable gloves (two different types, such as latex and vinyl)
- Safety goggles
- Absorbent (e.g. spill pillows, vermiculite, kitty litter, etc.)
- Plastic scoop
- Plastic trash bags
- Mercury spill kit (if mercury is present in thermometers or equipment in the lab).

8.2.3 Responding to Chemical Spills

The following sequence provides a brief overview of proper chemical spill response procedures:

- Notify others in the immediate area that a spill has occurred. Evacuate the area if necessary.
- Attend to injured and exposed people.
- Identify the spilled chemical and read the MSDS to determine the proper procedure for cleaning up the spill. If it is necessary for lab personnel to receive medical attention due to the chemical spill, share the MSDS information with first responders or emergency room medical staff.
- If the spilled material is flammable, turn off all ignition and heat sources.
- Based on the hazards and the personal protective equipment needed (e.g., respiratory protection), determine if you can safely clean the spill or if assistance is necessary. (Most spills can be cleaned safely by the people who were using the chemical.)

If you determine that you can safely clean the spill without emergency assistance, follow these guidelines:

- Wear appropriate protective clothing and equipment.
- Have another person stand by during the cleanup.
- Clean up the spill and collect all wastes for proper disposal.
- Ventilate the area, as necessary, before it is re-occupied.
- Decontaminate reusable cleanup supplies such as scoops, rubber boots, etc.

- Restock the chemical spill kit and return it to the normal storage location ***before using any more chemicals.***

Do not take unnecessary risks with chemical spills. Call EHS whenever a spill involves the following:

- Large volume of spilled material
- Very hazardous material
- Very hazardous conditions (e.g., fire, explosion, toxicity, etc.)
- Strong odor
- Personnel injury or exposure

APSU Chemical Hygiene Plan Section 9: Accidents / Injuries in the Lab

9.1 Emergency Situations

If an APSU employee (this includes student workers) is injured on the job and needs immediate medical attention, they may go to the Emergency Room at Gateway Hospital or to Doctors Care @ 2302 Madison St. Contact Human Resources or EHS to obtain authorization and an appointment at Doctors Care. If an ambulance is needed, call 911. The phone number for campus police is ext.7786. Contact information for the emergency contact for the lab should be listed on lab door signage.

9.1.1 Fire

If a fire occurs while working with highly hazardous chemicals, if possible to do so safely, close down the experiment. Take what steps are readily available to contain or minimize the spread of the chemical hazard. The first reaction to a fire is to evacuate the occupants of the building. In the event of a fire, pull the nearest pull station to alert and evacuate building occupants. Fire extinguishers are available in labs and may be used to extinguish small fires. Generally, a fire no larger than an office-sized trash receptacle can be put out with an extinguisher. If the fire is larger than a person, it generally is too big to be put out with an extinguisher. Fire extinguisher training is available from APSU EHS.

9.1.2 Chemical Exposures

All employees must be familiar with the location and proper use of safety showers and eyewash stations. Any chemical exposure to skin or eyes should be flushed with water for 15 minutes. Remove contaminated clothing and properly decontaminate the clothing.

Medical attention may be necessary in the following situations:

- Whenever an employee develops symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
- Where exposure monitoring reveals an exposure level routinely above the action level or PEL for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements.
- Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure.

Medical examinations and consultations will be provided through APSU's Workers' Compensation Program.

When medical treatment is necessary, provide the following information to the physician:

- The **identity** of the hazardous chemical(s) to which the employee may have been exposed.
- A description of the **conditions** under which the exposure occurred including quantitative exposure data, if available.
- A description of the **symptoms** of exposure that the employee is experiencing, if any.

9.1.3 Tornado

In the event of a tornado, if possible to do so safely, close down any experiment when working with highly hazardous chemicals. Take what steps are readily available to contain or minimize the spread of the chemical hazard. Proceed to the nearest tornado shelter inside the building where you are working. Every academic building on campus has an identified tornado shelter. In the event that the tornado shelter is full, go to the lowest floor of the building, remain in an interior hallway away from windows and doors.

9.2 Forms

All accidents or injuries that occur on campus must be reported to the EHS office and to Human Resources by completing the APSU Departmental Incident Report. All incidents that result in professional medical care must be reported on the State of Tennessee Accident Report to be submitted to the Workers' Compensation carrier. Both of these forms are available on the APSU Human Resources web site: Click on "HR Forms" on the left side, scroll down to Workers' Compensation Guide and Forms.

APSU Chemical Hygiene Plan Section 10: Chemical Storage

The following information provides guidance on safe and appropriate storage of chemicals.

Overview of Chemical Storage Groups
There are many ways to segregate chemicals into compatible storage groups. This plan provides one method that has wide applicability to research chemical inventories. It is based on nine storage groups. These groups include the following:

1. Flammable Liquids
2. Volatile Poisons
3. Oxidizing Acids
4. Organic and Mineral Acids
5. Liquid Bases
6. Liquid Oxidizers
7. Non-Volatile Poisons
8. Reactives
9. Solids

Seven of the groups cover storage of liquids due to the wide variety of hazards they pose. Each group is described in terms of its hazards, storage, examples, and compatibilities below.

Group 1 – Flammable Liquids
Primary hazard - Fires. Flammable liquids have flashpoints < 100° F. Avoid ignition sources and reactions that may cause fires. Recommended storage is in flammable storage cabinets.
Examples: All common low molecular weight alcohols (Methanol, Ethanol, etc.),
Acetone, Acetaldehyde, Acetonitrile, Amyl acetate, Benzene, Ethyl ether, Ethyl acetate, Hexane, Hydrazine, Tetrahydrofuran, Toluene, Xylenes.

Storage compatibilities: Flammable liquids and volatile poisons may be stored in the same vented compartment provided bases are not present.

Group 2 – Volatile Poisons
Primary hazard - Poisoning. Prevent inhalation and contact exposures.
Recommended storage is in vented storage cabinets, or a refrigerator for small containers that can be enclosed in a sealed secondary container. Put signs on storage location indicating the special hazard.
Examples Includes poisons, toxics and known and suspected carcinogens with strong odor or evaporation rate greater than 1 (butyl acetate = 1).
Examples: Carbon tetrachloride, Chloroform, Dimethylformamide, Dimethyl sulfate, Formamide, Formaldehyde, Halothane, Mercaptoethanol, Methylene chloride, Osmium tetroxide, Phenol.

Storage compatibilities: Volatile poisons may be stored in the same vented compartment as flammable liquids provided bases are not present.

Group 3 – Acids-Oxidizing

Primary hazard - Corrosion of skin and metals, some inhalation hazards, reactions with organic compounds and other acids and bases. Prevent skin contact and inhalation exposures, contact with other substances, and corrosive action on surfaces.

Recommended storage is in Safety Cabinet. Each oxidizing acid must be double-contained, i.e., the primary container must be kept inside canister, tray or tub. Segregate from bases, active metals (e.g. sodium, potassium, magnesium, etc.), organic chemicals and chemicals that could liberate toxic gases upon contact (e.g. sodium cyanide, iron sulfide, etc.).

Use bottle carriers or other secondary containment when transporting acid bottles. Store large bottles of acid on shelves waist height or lower. Place containers for acid and acid wastes in non-reactive spill trays to contain leaks or spills. Oxidizing acids must be double-contained and should be segregated in their own compartment in a safety cabinet. When quantities are small (e.g., 1 or 2 bottles) they do not warrant a separate compartment. Small quantities may be double-contained and stored with Group 4 Organic and Mineral Acids. Store oxidizing acids on bottom shelf below Group 4.

Examples: Chromic acid, Chromerge (Chromic/sulfuric acid concentrate), Perchloric acid, Nitric acid, Sulfuric acid.

Storage compatibilities: None.

Group 4: Organic and Mineral Acids

Primary hazard - These acids are generally noxious, corrosive to skin and steel, and some are flammable. Prevent contact and reaction with bases and oxidizing acids and corrosive action on surfaces.

Recommended storage is in a Safety Cabinet. Segregate acids from bases, from active metals (e.g. sodium, potassium, magnesium, etc.) and from chemicals that could liberate toxic gases upon contact (e.g. sodium cyanide, iron sulfide, etc.). Use bottle carriers or other secondary containment when transporting acid bottles. Store large bottles of acid on shelves waist height or lower. Place containers for acid and acid wastes in spill trays to contain leaks or spills. Plastic trays or Pyrex baking pans are effective and inexpensive.

Examples: Phosphoric acid, Acetic acid, Hydrochloric acid, Formic acid, Butyric acid.

Storage compatibilities: Small amount of double-contained oxidizing acids can be stored in the same compartment with organic acids if the oxidizing acids are stored on the bottom shelf.

Exceptions: Acetic anhydride and Trichloroacetic anhydride are corrosive. These organic acids are very reactive with oxidizing and mineral acids and should not be stored in this group. It is better to store these with organic compounds as in Group 7 Non-volatile Liquid Poisons.

Group 5: Liquid Bases

Primary hazard Liquid bases are corrosive to skin and steel. Prevent contact with skin and reaction with acids. Recommended storage is in safety cabinet or in tubs or trays in normal cabinet.

Examples: Sodium hydroxide, Ammonium hydroxide, Potassium hydroxide, Calcium hydroxide, and Glutaraldehyde.

Storage compatibilities: Liquid bases may be stored with flammables in the flammable cabinet if volatile poisons are not also stored there.

Group 6: Oxidizing Liquids

Primary hazard Oxidizing liquids are reactive with organic compounds. Prevent contact with skin and isolate from other materials. Oxidizing liquids react with a wide variety of compounds, potentially causing fires, explosions or corrosion of surfaces.
Recommended storage: Total quantities exceeding 3 liters should be kept in a cabinet housing no other chemicals. Smaller quantities must be double-contained if kept near other chemicals, e.g., in a refrigerator.
Examples: Methyl ethyl ketone peroxide, Ammonium persulfate solutions, and hydrogen peroxide (if greater than or equal to 30%)
Storage compatibilities: None.

Group 7: Non-Volatile Liquid Poisons
Primary hazard: Prevent contact with skin and reactive substances.
Recommended storage: Cabinet or refrigerator (i.e., must be enclosed). Do not store on open shelves in the lab or cold room. Liquid poisons in containers larger than 1 liter must be stored below bench level on shelves closest to the floor. Smaller container of liquid poison can be stored above bench level only if behind sliding (non-swinging) doors.
Examples: highly toxic (LD50 oral rat < 50 mg/kg) and toxic chemicals
(LD50 oral rat < 500 mg/kg), known carcinogens, suspected carcinogens and mutagens.
Acrylamide solutions; Diethylpyrocarbonate; Diisopropyl fluorophosphate; uncured Epoxy resins; Ethidium bromide; Triethanolamine.
Storage compatibilities: Non-hazardous liquids (e.g., buffer solutions). Exceptions: Anhydrides, e.g., Acetic and Trichloroacetic, are organic acids, however it is better to store with this group than with Group 4 Organic Acids, since they are highly reactive with other organic, oxidizing or mineral acids.

Group 8: Reactive Metal Hydrides, Pyrophorics, and Water Reactives
Primary hazard: Most metal hydrides react violently with water, some ignite spontaneously in air (pyrophoric). Water-reactives react with water, usually generating heat, corrosive liquid and flammable gases.
Recommended storage: Secure water-proof double-containment according to label instructions. Isolation from other storage groups. The primary storage concern is to prevent contact and reaction with liquids and, in some cases, air.
Examples: Some metal hydrides are Sodium borohydride, Calcium hydride, Lithium aluminum hydride.
Some pyrophorics are Boron, Diborane, Dichloroborane, 2- Furaldehyde, Diethyl aluminum chloride, Lithium, white or yellow Phosphorus and Trimethyl aluminum. Water reactives include Aluminum chloride-anhydrous, Calcium carbide, Acetyl chloride, Chlorosulfonic acid, Sodium metal, Potassium metal, Phosphorous pentachloride, Calcium metal, Aluminum tribromide, Calcium oxide, and acid anhydrides.
Storage compatibilities: If securely double-contained to prevent contact with water and/or air, metal hydrides may be stored in the same area as Group 9 Dry Solids.

Group 9: Dry Solids
Primary hazard: Includes all salts, powders, and granules. These may be hazardous and non-hazardous.
Recommended storage: The primary storage concern is to prevent contact and potential reaction with liquids. Cabinets are recommended, but if not available, open shelves are acceptable. Store

above liquids. Warning labels on highly toxic powders should be inspected and highlighted or amended if they do not cause the containers to stand out against less toxic substances in this group. It is recommended that the most hazardous substances in this group be segregated. It is particularly important to keep liquid poisons below cyanide-or sulfide-containing poisons (solids). A spill of aqueous liquid onto cyanide - or sulfide - containing poisons would cause a reaction that would release poisonous gas. Metal hydrides, if properly double-contained, may be stored in the same area.
Examples: Benzidine, Cyanogen bromide, Ethyl maleimide, Oxalic acid, Potassium cyanide, Sodium cyanide, Iron sulfide, Urea, Sodium thiosulfate.
Storage compatibilities: All other solids.
Exceptions: solid Picric acid or Picrylsulfonic acid can be stored with this group, but should be checked regularly for dryness. When completely dry, picric acid is explosive and may detonate upon shock or friction. Picric acid in contact with some metals may form explosive metal-picrate salts. Use non-metal caps.

The Chemical Compatibility Chart that follows may also be of assistance in determining appropriate storage of chemicals.

APSU Chemical Hygiene Plan Section 11: Fume Hoods

The laboratory fume hood is the major protective device available to laboratory workers. It is designed to capture chemicals that escape from their containers or apparatus and to remove them from the laboratory environment before they can be inhaled. Fume hoods also provide physical protection against fire, spills, and explosion.

11.1 When to Use a Fume Hood

Characteristics to be considered in requiring fume hood use are **physical state, volatility, toxicity, flammability, eye and skin irritation, odor, and the potential for producing aerosols**. A fume hood should be used if a chemical procedure exhibits any one of these characteristics:

- Airborne concentrations might approach an OSHA exposure limit,
- Flammable vapors might approach one tenth of the lower explosion limit,
- Materials of unknown toxicity are used or generated, or
- Odor produced is irritating to laboratory occupants or adjacent units.

Procedures that can generally be carried out safely outside the fume hood (depending on the capacity of the general ventilation system to remove any airborne contaminants) include those involving:

- **Water-based solutions** of salts, dilute acids, bases, or other reagents,
- **Very low volatility** liquids or solids (provided they are low toxicity),
- **Closed systems** that do not allow significant escape to the laboratory environment,
- **Extremely small quantities** of otherwise problematic chemicals.

It is sometimes difficult to tell if the fume hood fan motor is operational. Without the fan, the fume hood system will not provide adequate protection. All hoods should be equipped with an airflow monitor, but if you suspect the monitor isn't working correctly, a piece of "Kim Wipe" taped at the bottom of the sash will give an indication of air movement into the hood. Notify APSU EHS immediately if you suspect the fume hood is not operational.

Fume hoods are tested annually by APSU EHS. The test includes an inspection of the hood system, airflow measurements and an assessment of the use of the fume hood. Additionally fume hoods are tested after a repair.

11.2 Guidelines for Appropriate Fume Hood Use

- Keep the hood clear and uncluttered. Numerous bottles and pieces of equipment in a hood interfere with proper airflow, and in an accident they increase the hazard and complicate cleanup.
- All work should be performed at least 6 inches inside the hood.

APSU Chemical Hygiene Plan Section 12: TRAINING DOCUMENTATION

Laboratory personnel must receive general and laboratory-specific training.

12.1 General Training

Each fall and spring semester, EHS offers Lab Safety training. All lab personnel should receive this training annually.

Laboratory personnel may also participate in other trainings, as appropriate, for example:
- Fire Extinguisher Training
- First Aid and CPR

12.2 Laboratory-Specific Training

Laboratory-specific training is to be provided by the PI/Laboratory Supervisor or his/her designee, addressing the specific chemical hazards present and emergency procedures specific to the laboratory. Also, any lab-owned equipment may require specialized training to prevent equipment damage. This can be achieved via a combination of the following:

a. Review of any individual Laboratory Safety Plan.
b. Review of local/ building safety information.
c. Review of Standard Operating Procedure(s) involving hazardous chemicals.
d. Other laboratory-specific training on particular safety procedures or hazards encountered in the laboratory environment.

12.3 Recordkeeping of Safety Training

All health and safety training records are to be maintained by the PI/Laboratory Supervisor or designee for at least one year. A sample training documentation sheet is at the end of this section.

Appendices

Appendix A

APSU Chemical Inventory

Department

Departmental Chair

Chemical	Manufacturer	Storage Location (Building and Room Number)	CAS Number (if applicable)
-	-		
-	-		
-	-		
-	-		

-	-		
-	-		

Appendix B

Appendix B
Laboratory Hazard Assessment Form

General Information:

Building: _____ Room Number: _____

Department/Unit:_____

Process/Procedure (Explain Task): _____
_____
_____
_____
_____

□ Routine □ Non-routine

Hazards/ Potential Hazards Assessment:

□ Chemical (Vapor/Dust)	□ Noise	□ Thermal
□ Fire/Explosion	□ Non-Ionizing Radiation	□ Ergonomic
□ Biological	□ Ionizing Radiation	□ Other

Explain:_____
_____
_____

Monitoring Results:
_____
_____

Accident Probability: □ Low □ Moderate □ High
Accident Severity: □ Low □ Moderate □ High

Personal Protective Equipment Required:

	Required	PPE (See Code List)	Hazard Source
Eyes			
Face			
Head			
Foot			
Hand			
Body			
Hearing			
Respiratory			

Appendix C: Guidelines for Preparing Laboratory Specific Standard Operation Procedures

Laboratories must provide standard operating procedures (SOPs) for work involving the laboratory use of hazardous chemicals. See the definition of "Hazardous chemical" in the CHP section entitled, "Scope of Application." In most cases, more than one SOP will be required. All hazardous chemicals used in the laboratory must be covered by an SOP.

There are three methods that can be used to write SOPs. They are:

- By process: (distillation, synthesis, chromatography, etc.).
- By individual hazardous chemical: (arsenic, benzene, hydrochloric acid, etc.).
- By hazardous chemical class: (flammable, corrosive, oxidizer, etc.).

These methods may be used alone or in combination. A sample form is provided in this appendix to assist in the preparation of SOPs. The form consists of nine sections and should contain the information listed below.

Section 1. Process, Hazardous Chemical, or Hazard Class - circle one.

- Process - Describe the process that involves hazardous chemicals. List all chemicals used in the process.
- Hazardous Chemical - Name the hazardous chemical for which the SOP is being developed. Include IUPAC (International Union of Pure and Applied Chemistry), common name, and any abbreviation(s) used for the chemical.
- Hazard Class - Describe the hazard associated with a particular group of similar chemicals and list the chemicals used in the laboratory.

Section 2. Describe Process, Hazardous Chemical, or Hazard Class.

Section 3. Potential Hazards - Describe the potential hazards for each process, hazardous chemical or hazard class. Include physical and health hazards.

Section 4. Personal Protective Equipment - Identify the required level of personal protective equipment and hygiene practices needed for each process, hazardous chemical or hazard class.

Personnel protective equipment includes: gloves, aprons, lab coats, safety glasses, goggles, face-shields, and respirators. (Note: Before using respirators, all employees must be entered into the University's Respiratory Protection Program. Call EH&S at 6103 for more information.)

Section 5. Engineering Controls - Describe engineering controls that will be used to prevent or reduce employee exposure to hazardous chemicals for the process, hazardous chemical or hazard class. This includes ventilation devices such as fume hoods, gloveboxes, etc.

Section 6. Special Handling & Storage Requirements - List storage requirements for the hazardous chemicals involved with the SOP, including specific storage areas, and policies regarding access to chemicals. Special procedures such as dating peroxide formers and testing them before distillation are appropriate here.

Appendix D

TRAINING TITLE: _____

DATE: _____ TRAINER: _____

Name (Please Print)	Department

Duke University Particularly Hazardous Substances

https://www.safety.duke.edu/laboratory-safety/chemical-hygiene/particularly-hazardous-substances