

<b>Johns Hopkins Safety Manual</b>	<i>Guidance Document</i>	<b>HSE G07</b>
<i>Subject:</i> GUIDANCE FOR PRUDENT PRACTICES FOR CHEMICAL USE (BY HAZARD CLASS) IN LABORATORIES	<i>Review Date</i>	Sep-11
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### **Rationale**

The Johns Hopkins Institutions is committed to provide a safe environment for staff and students to perform the necessary laboratory procedures for completion of their research or education. A basic part of providing this environment is to ensure that everyone in the laboratory follows standard operating procedures (SOP) on how to safely work with a specific chemical hazard classes. This SOP is generic in nature. It addresses the use and handling of substances generally or by hazard *class* only.

### **RESPONSIBILITIES**

Departmental Chairs/  
Principle Investigator/  
Supervisor      Require that each staff member and student follow standard operating procedures as developed by Heath Safety and Environment (HSE) or other science based safety criteria prior to initiating work in the laboratory.

Provide lab specific training in safe practices for the procedures in use in their specific laboratory.

Provide HSE documentation of all laboratory specific training that was provided.

HSE      Develop and/or assist in development of standard operating procedures that will present information on safe work practices for that laboratory that is generic to all laboratory settings.

Review the SOPs periodically to ensure that the information remains current.

Provost      Support efforts by HSE to provide SOPs and other safety information deemed appropriate by HSE.

Laboratory Staff/  
Students      Follow laboratory standard operating procedures and protocols and attend any other safety training deemed appropriate by HSE for the work they are performing.

### **REVIEW CYCLE**

Annual

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### Guidance and Prudent Practices for Chemical Use in Laboratories

PLEASE NOTE: The following are basic guidelines that apply to **all hazard classes** of chemicals. Specific Standard Operating Procedure (SOP) components must be used in *addition* to the basic guidelines for specific hazard classes (acutely toxic, carcinogens, pyrophoric, and reproductive chemicals). **Specific written procedures are the responsibility of the Laboratory's Principle Investigator/Faculty.**

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#### Important Contact Information

Emergency	JHMI 955-4444	JHU 516-7777
Health Safety & Environment	JHMI 955-5918	JHU 516-8798
Occupational Health Services	JHMI 955-6211	JHU 516-0450
Material Safety Data Sheets	CHEMWATCH	<a href="http://jr.chemwatch.net/chemgold3/">http://jr.chemwatch.net/chemgold3/</a>
Poison Control Center	(800) 222-1222	

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### General Laboratory Chemical Use Prudent Practices

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances generally or by hazard *class* only. In some instances, multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). While SOPs provide only general guidance, observance of all the safety practices listed in them is mandatory. If compliance with all the requirements of a specific standard operating procedure is not possible, the Laboratory Supervisor or Lead Instructor must develop a written procedure that will be used in its place. This alternate procedure must provide **at least the same level of protection** (equally stringent) as the SOP it replaces. If you have questions concerning the applicability of any items listed in this procedure, contact the Supervisor or Lead Instructor for your laboratory or the Office of Health, Safety, & Environment.

#### Decontamination procedures

Personnel: Wash hands and arms with soap and water immediately after working with chemicals.

Area: Decontamination procedures vary depending on the material being handled. The hazard of some materials (e.g., acids) can be neutralized with other reagents (e.g., sodium bicarbonate). All surfaces must be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated are usually treated as a hazardous waste.

Equipment: Decontaminate all contaminated equipment (e.g., glassware) before removing it from the designated area.

#### Designated areas

Room signs for laboratories using or containing *acutely toxic gases, acutely toxic chemicals, carcinogens, or reproductive hazards* must identify the specific hazard.

All locations within the laboratory where such chemicals are handled must be posted with appropriate designated area caution signs. This includes all fume hoods and bench tops where such chemicals are handled.

#### Emergency procedures

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of signs and symptoms of overexposure must be developed. The procedures must address as a minimum the following:

1. Who to contact: (HSE, Occupational Health, Laboratory Supervisor, etc.)
2. The location of all safety equipment (showers, eye wash, fire extinguishers, etc.)
3. The method used to alert personnel in nearby areas of potential hazards
4. Special first aid treatment required by the type of material(s) handled in the laboratory.

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### **Eye protection**

Eye protection must be worn at all times when handling chemicals. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Safety glasses must meet the requirements of the *Practice for Occupational and Educational Eye and Face Protection (ANSI.Z.87. 1 1989)* and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes, therefore, when the potential for splash hazard exists, other eye protection (e.g., chemical goggles or face protection, such as a face shield) must be worn.

### **Eye washes**

Where the eyes of any person may be exposed to chemicals, suitable facilities (eyewashes) for quick drenching or flushing of the eyes shall be provided within the work area for immediate emergency use.

### **Fume hoods**

Manipulation of certain types of chemicals must be carried out in a fume hood. If the use of a fume hood proves impractical, refer to the sections on special ventilation. See SOP's for individual hazard classes for further guidance.

### **Glove (dry) box**

Certain chemicals must be handled in a glove box rather than a fume hood. Lab Supervisor/Lead Instructor and/or HSE will determine if this is required.

### **Gloves**

Suitable gloves shall be worn when handling chemicals.

### **Hazard assessment**

Hazard assessment must focus on proper use and handling procedures, the education of employees concerning the health risk posed by chemicals in use, and on the demarcation of designated areas.

### **Protective apparel**

At a minimum, lab coats closed toed shoes and long sleeved clothing must be worn when handling chemicals. Additional protective clothing must be worn if the possibility of skin contact is likely, and/or depending on the type of material being used in the laboratory.

### **Safety shielding**

Safety shielding is required any time there is a risk of explosion or a highly exothermic reaction. For example, manipulations of reactive liquids, or any other materials which pose this risk, must occur in a

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fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

### **Safety shower**

A safety or drench shower must be available in a nearby location where acutely toxic, flammable, carcinogenic, corrosive, pyrophoric, oxidizing, or highly reactive or water-sensitive chemicals are used.

### **Signs and labels**

Doorways: The lab entrance must be posted with a yellow "Caution" sign where carcinogens, reproductive hazards, and/or acutely toxic chemicals are stored and/or used.

Containers: All chemicals must be clearly labeled with the correct English chemical name and date. Handwritten labels are acceptable; chemical formulae and structural formulae are NOT acceptable.

### **Special storage**

Acutely toxic, carcinogenic, or reproductive hazard chemicals must be stored in a designated area.

### **Special ventilation**

Manipulation of some chemicals outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to many chemicals in the laboratory and are often the preferred ventilation control device. See hazard class-specific SOP's following this section for further guidance.

Chemicals that are volatile must not be used in a biological safety cabinet unless the cabinet is vented to the outdoors.

### **Spill response**

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the Material Safety Data Sheet. This must occur prior to the use of any chemical.

In the event of a spill, alert personnel in the area that a spill has occurred. Minor spill clean up is expected to be completed by laboratory personnel. Do not attempt to handle a large spill of acutely toxic, carcinogenic, corrosive, flammable, highly reactive or water-sensitive chemicals. Vacate the laboratory immediately, close doors and call for assistance

Emergency (Fire or Medical Emergency)                      JHMI 955-4444                      JHU 516-7777

Health Safety & Environment                                      JHMI 955-5918                      JHU 516-8798

Remain on the scene, *but at a safe distance*, to receive and direct safety personnel when they arrive.

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### **Vacuum protection**

Evacuated glassware can implode and eject flying glass and splattered chemicals. Vacuum work involving certain chemicals (e.g., acutely toxic chemicals) must be conducted in a fume hood, or isolated in an acceptable manner.

Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood.

### **Waste disposal**

Most waste chemicals must be disposed of as a hazardous waste. Wherever possible, attempt to design research in a manner that reduces the quantity of waste generated. All excess and/or unwanted hazardous material must be properly identified, labeled and stored until delivered to HSE for disposal. Questions regarding waste disposal should be directed to the Office of Health, Safety & Environment 410-955-5918. This office can also assist you in minimizing waste generation.

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**STANDARD OPERATING PROCEDURES FOR: ACUTELY TOXIC GASES**

A list of acutely toxic gases is included in Appendix A.

**Securing of gas cylinders**

Cylinders of compressed gases must be handled as high energy sources. When storing or moving a cylinder, have the cap securely in place to protect the stem. Use suitable racks, straps, chains or stands to support cylinders.

**Designated area**

The room sign for the laboratory must contain a “*Caution*” identifier with “*Acutely Toxic Gas*” identifier.

All locations within the laboratory where acutely toxic gases are handled must be demarcated with designated area caution tape and/or posted with designated area caution signs.

This includes all fume hoods and bench tops where the acutely toxic gases are handled.

**Fume hoods**

Manipulation of acutely toxic gases must be carried out in a fume hood. All areas where acutely toxic gases are stored or manipulated must be labeled as a designated area.

**Glove (dry) box**

Some processes involving acutely toxic gases may be performed in a properly vented glove box rather than a fume hood.

**Safety shielding**

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of acutely toxic gases which pose this risk must occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

**Safety shower**

A safety or drench shower must be available in a nearby location where the acutely toxic gases are used.

**Signs and labels**

Doorways: The lab entrance must be posted with a yellow “*Caution*” sign where carcinogens, reproductive hazards, and/or acutely toxic gases are stored or used.

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**Containers:** All acutely toxic gas cylinders must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulae and structural formulae are **NOT** acceptable.

### Special storage

Acutely toxic gases, if used, must be stored in a designated area. Special ventilation of the stored cylinders is required and must be inspected and approved by HSE. Acutely toxic gases are forbidden in cold rooms/confined spaces.

Continuous monitoring devices which will alert staff of a release of the acutely toxic gas, and/or automatic shut off capability are required for certain gases.

The quantity of an acutely toxic gas that may be stored in a laboratory will be determined on a case-by-case basis by the Office of Health, Safety & Environment.

### Special ventilation

Manipulation of toxic gases outside of a fume hood will require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to acutely toxic gases in the laboratory and are the preferred ventilation control device. Always attempt to handle acutely toxic gases in a fume hood. If your research does not permit the handling of acutely toxic gases in your fume hood you must contact HSE to review the adequacy of all special ventilation.

### Waste disposal

All empty or partially filled acutely toxic gas cylinders must be returned to the supplier. If the supplier does not accept empty or partially filled cylinders, contact Health, Safety & Environment personnel concerning disposal.

### Acutely Toxic Gases\*

Name	CAS #	Name	CAS#
Arsenic pentafluoride	7784-36-3	Oxygen difluoride	7783-41-7
Arsine	7784-42-1	Phosgene	75-45-5
Boron trifluoride	7636-06-2	Phosphine	1498-40-4
Chlorine	7782-50-5	Phosphorus pentafluoride	7641-19-0
Diazomethane	334-88-3	Selenium hexafluoride	7783-79-1
Diborane	19287-45-7	Silicon tetrafluoride	7783-61-1
Fluorine	7681-49-4	Stilbine	10025-91-9
Methyl mercaptan	74-93-1	Sulfur tetrafluoride	7783-60-0

\* This list is provided as a guide and is not all inclusive. Carefully review Material Safety Data Sheets before working with chemicals.

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**STANDARD OPERATING PROCEDURES FOR: ACUTELY TOXIC CHEMICALS**

**Decontamination procedures**

Personnel: Thoroughly wash hands, arms and any other areas of the body which may have come in contact with acutely toxic chemicals, with large amounts of soap and water. Do not touch eyes or mouth with your hands immediately after using such chemicals. ***IF ANY SIGNS OR SYMPTOMS OF OVEREXPOSURE OCCUR, SEEK IMMEDIATE MEDICAL ATTENTION BY CALLING SECURITY, HSE, and the POISON CONTROL CENTER!***

Area: Decontamination procedures vary depending on the material being used. All surfaces must be wiped with the appropriate cleaning agent following dispensing or manipulations. Waste materials generated must be treated as a hazardous waste. NEVER allow acutely toxic chemicals to be discharged to the sewer drain.

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

**Designated area**

The room sign must contain a "Caution" identifier and appropriate hazard warning.

All locations within the laboratory where acutely toxic chemicals are used or stored must be posted with designated area caution signs. This includes all fume hoods and bench tops where the acutely toxic chemicals are handled.

Where feasible, acutely toxic chemicals must be manipulated over plastic-backed disposable paper covered work surfaces.

These disposable work surfaces minimize work area contamination and simplify clean up.

**Emergency procedures**

Emergency procedures must include special first aid supplies (e.g., *syrup of ipecac* for possible inducement of vomiting, if appropriate), and antidote treatment required by the type of acutely toxic chemicals used in the laboratory. Contact HSE for direction. **Requires Lab Specific SOP**

**Eye washes**

Where the eyes or body of any person may be exposed to toxic chemicals, suitable facilities for quick drenching or flushing of the eyes and body shall be provided in the work area for immediate emergency use.

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### **Fume hoods**

Manipulation of acutely toxic chemicals must be carried out in a fume hood or, in some cases, a glove box.

### **Glove (dry) box**

Certain acutely toxic chemicals must be used in a glove box rather than a fume hood. HSE or the Lab Supervisor/Lead Instructor will determine if this is required.

### **Hazard Assessment**

Focus on proper use and handling procedures, education of employees and students concerning the health hazards/ signs of overexposure associated with acutely toxic chemicals, proper hygiene, and personal protective equipment and on the demarcation of designated areas.

### **Signs and labels**

Doorways: The lab entrance must be posted with a yellow "*Caution*" sign warning that acutely toxic chemicals are stored or used.

Containers: As with all chemicals, acutely toxic chemicals must be clearly labeled with the correct chemical name.

Handwritten labels are acceptable; chemical formula or structural formulas are not acceptable.

### **Special Storage**

Acutely toxic chemicals must be stored in a designated area.

### **Spill Response**

Do not attempt to handle a spill of acutely toxic chemicals. Vacate the laboratory immediately, close doors and call HSE for assistance.

Remain on the scene, *but at a safe distance*, to receive and direct emergency personnel upon their arrival.

### **Waste disposal**

All materials contaminated with acutely toxic chemicals must be disposed of as hazardous waste. Whenever possible, design procedures that reduce or minimize the quantity of acutely toxic chemicals used and disposed of as hazardous waste.

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### Acutely Toxic Chemicals\*

Acrolein	Acrylyl chloride	2-Aminopyridine
Benzyl chloride	Bromine	Chlorine dioxide
Chlorine trifluoride	Chlorpicrin	Cyanogen chloride
Cyanuric fluoride	Decaborane	Dichloro acetylene
Dimethyl Disulfide	Dimethylsulfate	Dimethylsulfide
Ethylene Chlorohydrin	Ethylene Fluorohydrin	Hexamethylene diisocyanate
Hexamethyl phosphoramidate	Iodine	Iron pentacarbonyl
Isopropyl formate	Methacryloyl chloride	Methacryloxyethyl isocyanate
Methyl acrylonitrile	Methyl chloroformate	Methylene biphenyl isocyanate
Methyl fluoroacetate	Methyl fluorosulfate	Methyl hydrazine
Methyltrichlorosilane	Methyl vinyl ketone	Nickel carbonyl
Nitrogen tetroxide	Nitrogen trioxide	Organo Tin compounds
Osmium tetroxide	Oxygen difluoride	Ozone
Pentaborane	Perchloromethyl mercaptan	Phosphorus oxychloride
Phosphorus trichloride	Sarin	Sulfur monochloride
Sulfur pentafluoride	Sulfuryl chloride	Tellurium hexafluoride
Tetramethyl succinonitrile	Tetranitromethane	Thionyl chloride
Toluene-2,4-diisocyanate	Trichloro(chlormethyl)silane	

\* This list is provided as a guide and is not all inclusive. Carefully review Material Safety Data Sheets before working with chemicals.

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## STANDARD OPERATING PROCEDURES FOR: CARCINOGENS

A “*carcinogen*” commonly describes any agent that can initiate or speed the development of malignant or potentially malignant tumors, malignant neoplastic proliferation of cells, or cells that possess such material.

### Designated area

The room number sign for the laboratory must contain a “*Caution*” identifier with “*carcinogen*” hazard identified.

All locations within the laboratory where carcinogens are handled must be demarcated with designated area caution tape and/or posted with designated area caution signs. This includes all fume hoods and bench tops where the carcinogens are handled.

Where feasible, carcinogens must be manipulated over plastic-backed disposable paper covered work surfaces. These disposable work surfaces minimize work area contamination and simplify clean up.

### Fume hoods

Manipulation of carcinogens must be carried out in a fume hood. If the use of a fume hood proves impractical, refer to the section on special ventilation.

All areas where carcinogens are stored or manipulated must be labeled as a designated area.

### Glove (dry) box

Certain carcinogens must be handled in a glove box rather than a fume hood. Health, Safety & Environment or the Lab Supervisor will determine if this is required.

### Signs and labels

Doorways: The lab entrance must be posted with a yellow “*Caution*” sign warning where carcinogens are stored or used.

Containers: All containers of carcinogens must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulae and structural formulae are not acceptable.

### Special storage

Carcinogens must be stored in a designated area.

### Special ventilation

Manipulation of carcinogens outside of a fume hood may require special ventilation controls in order to

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minimize exposure to the material. Fume hoods provide the best protection against exposure to carcinogens in the laboratory and are the preferred ventilation control device. When possible, handle carcinogens in a fume hood. If the use of a fume hood proves impractical, attempt to work in a glove box or on an isolated area on the bench top.

If necessary or prudent, consider for using a Biological Safety Cabinet must be considered. The biological safety cabinet is designed to remove particulates (the carcinogen) before the air is discharged into the environment. *Carcinogens that are volatile must not be used in a biological safety cabinet.*

If your research does not permit the handling of carcinogens in a fume hood, biological safety cabinet, or glove box, you must contact Health, Safety & Environment.

All areas where carcinogens are stored or manipulated must be labeled as a designated area.

### Vacuum protection

Evacuated glassware can implode and eject flying glass and splattered chemicals. Vacuum work involving carcinogens must be conducted in a fume hood, glove box or isolated in an acceptable manner.

Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood.

### Waste disposal

All materials contaminated with carcinogens must be disposed of as hazardous waste. Wherever possible, attempt to design research in a manner that reduces the quantity of waste generated. Questions regarding waste disposal should be directed to Health, Safety & Environment. This office can also assist you in minimizing waste generation.

#### Select Carcinogens\*

Name	CAS#	Name	CAS#
Arsenic and Arsenic compounds	7440-38	Asbestos	12001-29-5
Azathioprine	446-86-6	Benzene	71-43-2
Benzidine	92-87-5	N,N-bis(2-chloroethyl)-2-naphthylamine Bis(chloromethyl)ether	494-03-1
1,4-Butanediol dimethylsulfonate (myleran)	55-98-1	Certain combined chemotherapy for lymphomas	
Chlorambucil	305-03-3	Chloromethyl methyl ether (technical grade)	107-30-2
Chromium and chromium compounds	7440-47-3	Conjugated estrogens	
Melphalan	148-82-3	Methoxsalen with ultra-violet A therapy (PUVA)	
2-Naphthylamine	91-59-8	Soots, tars, and mineral oils	
Thorium dioxide	1314-20-1	Vinyl chloride	75-01-4

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## STANDARD OPERATING PROCEDURES FOR: COMPRESSED GASES

Additional requirements may apply if the material is an acutely toxic compressed gas. Please refer also to the SOP for acutely toxic gases, if applicable.

### Securing of gas cylinders

Cylinders of compressed gases must be handled as high- energy sources (sudden pressure release hazard). They pose a serious hazard if the cylinder valve is dislodged. When storing or moving a cylinder, have the cap securely in place to protect the stem. Use suitable racks, straps, chains or stands to support cylinders.

### Designated area

Compressed gas cylinders which contain acutely toxic gases must be stored in a designated area. Compressed gas cylinders are forbidden to be stored in cold rooms/confined spaces. See the SOP for acutely toxic compressed gases.

### Fume hoods

Manipulation of compressed gases must be carried out in a fume hood if the compressed gas is an irritant, oxidizer, asphyxiant, or has other hazardous properties.

### Hazard assessment

Hazard assessment for work with compressed gases must assure that all staff understands proper use and handling precautions; that all pressurized equipment is properly shielded; regulators are not interchanged between different gas types; all hose connections are properly secured and are appropriate for the pressure(s) used.

### Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of compressed gases which pose this risk must occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

### Labels

All compressed gases must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulae and structural formulae are not acceptable. *The compressed gas cylinder must be labeled to indicate if the container is full or empty.*

### Special storage

Cylinders must be stored in an upright position and secured to a wall or laboratory bench through the use



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## STANDARD OPERATING PROCEDURES FOR: CORROSIVE CHEMICALS

Corrosive chemicals are substances that cause visible destruction or permanent changes in human skin tissue at the site of contact, or are highly corrosive to steel. The major classes of corrosives include strong acids, bases (alkalis), and dehydrating agents.

### Decontamination procedures

Personnel: Immediately flush contaminated area with *copious* amounts of water after contact with corrosive materials. Remove any jewelry to facilitate removal of chemicals. If a delayed response is noted, seek immediate medical attention. Be prepared to detail what chemicals were involved.

If the incident involves Hydrofluoric acid (HF), seek immediate medical attention. Laboratories using HF must have Calcium Gluconate on hand to begin immediate first aid treatment. Seek immediate medical attention if exposure occurs!

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

### Eye protection

Eye protection must be worn at all times when handling corrosive materials. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.)

Adequate safety glasses must meet the requirements of the Practice for Occupational and Educational Eye and Face protection (ANSI Z 87.1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists, other eye protection and/or face protection must be worn. It is recommended that face shields be worn when a splash potential exists with corrosive materials.

### Eye Washes

Where the eyes or body of any person may be exposed to corrosive chemicals, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use.

### Fume hoods

Manipulation of corrosive substances must be carried out in a fume hood if corrosive vapor production is anticipated.

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## Gloves

Appropriate gloves must be worn when handling corrosive materials.

## Hazard assessment

Hazard assessment must include instruction on proper use and handling, spill control, and splash protection

## Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of corrosive materials which pose this risk must occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

## Safety shower

A safety or drench shower must be available in a nearby location where the corrosive material is used.

## Signs and labels

Containers: All corrosive chemicals must be clearly labeled with the correct English chemical name. Handwritten labels are acceptable; chemical formulae and structural formulae are not acceptable.

## Special storage

Segregate the various types of corrosives. *Separate acids and bases.* Liquids and solids must also be separated. Specially designed corrosion resistant cabinets must be used for the storage of large quantities of corrosive materials. Store corrosives on plastic trays. *Do not store corrosive materials on high cabinets or shelves.*

## Special ventilation

Manipulation of some corrosive materials outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to corrosive materials in the laboratory and are the preferred ventilation control device.

## Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the Material Safety Data Sheet. This must occur prior to the use of any corrosive chemical. Corrosive spill controls neutralize the hazardous nature of the spilled material. Acids and bases require different types of spill control materials.

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### **Waste disposal**

Most corrosive materials are hazardous wastes (e.g., EPA defines a pH of less than 2 or greater than 12 to be one of many *characteristic* property types of hazardous waste. There are many *listed* chemicals as well, deemed as hazardous wastes. All waste corrosives must be disposed through the University's hazardous waste program coordinated by Health, Safety & Environment. Questions regarding waste disposal should be directed to Health, Safety & Environment.

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## STANDARD OPERATING PROCEDURES FOR: FLAMMABLE LIQUIDS

Flammable liquids are chemicals that have a flash point below 100° F (38.7° C).

### Fume hoods

When possible, experiments involving greater than 500 mL of flammable liquids must be carried out in a fume hood.

### Hazard assessment

Hazard assessment for work involving flammable liquids must thoroughly address the issues of proper use and handling, fire safety, chemical toxicity, storage, and spill response.

### Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of flammable liquids which pose this risk must occur in a fume hood with the sash in the lowest feasible position. Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. Portable shields, which provide protection to all laboratory occupants, are acceptable.

### Safety shower

A safety or drench shower must be available in a nearby location where the flammable liquids are used.

### Special storage

The storage of flammable and combustible liquids in a laboratory, shop or building area must be kept to the *minimum needed for research and/or operations*. A flammable-liquids storage cabinet is required when more than 10 gallons (accumulative) of flammables are present in the laboratory and not stored in metal safety cans. Flammable-liquids storage cabinets are not intended for the storage of highly toxic materials, acids, bases, compressed gases or pyrolytic chemicals.

### Special ventilation

Manipulation of flammable liquids outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to flammable liquids in the laboratory and are the preferred ventilation control device. Always attempt to handle large quantities of flammable liquids in a fume hood. If your research does not permit the handling of large quantities of flammable liquids in your fume hood, contact Health, Safety & Environment to review the adequacy of all special ventilation.

### Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up

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supplies can be determined by consulting the Material Safety Data Sheet. This must occur prior to the use of any flammable liquids. Spill supplies for flammable liquids are designed to control the liquids portion of the spill and minimize the production of flammable vapors. Never use paper towels on large spills of flammable liquids because it exacerbates vapor production.

In the event of a spill, all personnel in the area must be alerted. *Turn off all sources of ignition.* Do not attempt to handle a large spill of flammable liquids. Vacate the laboratory immediately and call for assistance.

### **Vacuum protection**

Evacuated glassware can implode and eject flying glass, and splattered chemicals. Vacuum work involving flammable liquids must be conducted in a fume hood, glove box or isolated in an acceptable manner.

Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood. Vacuum pumps must be rated for use with flammable liquids.

### **Waste disposal**

Flammable liquids are hazardous wastes. Questions regarding waste disposal should be directed to the Health, Safety & Environment.

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## STANDARD OPERATING PROCEDURES FOR: OXIDIZING CHEMICALS

Oxidizing chemicals are materials that spontaneously evolve oxygen at room temperature or with slight heating, or promote/support combustion. Examples of the classes of chemicals considered “oxidizers” include peroxides, chlorates, perchlorates, nitrates, and permanganates. Strong oxidizers are capable of forming explosive mixtures when mixed with combustible, organic or materials that can burn.

### Decontamination procedures

Area: Carefully clean work area after use. *Paper towels or similar materials contaminated with strong oxidizing chemicals may pose a fire risk.*

### Fume hoods

The use of certain concentrations of *perchloric acid* must be performed in a fume hood equipped with wash down facilities. Contact Health, Safety & Environment regarding fume hood requirements.

### Hazard assessment

Hazard assessment must address proper use and handling techniques, fire safety, storage, and waste disposal issues.

### Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of oxidizing chemicals which pose this risk must occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

### Signs and labels

Containers: All oxidizing chemicals must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulae and structural formulae are not acceptable.

### Special storage

Oxidizers must be stored in a cool and dry location. Keep oxidizers segregated from all other chemicals in the laboratory, especially flammables and combustibles. Minimize the quantities of strong oxidizers stored in the laboratory.

Never return excess chemicals to the original containers. Small amounts of impurities may be introduced into the container, which may cause a fire or explosion.

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### Special ventilation

The use of certain concentrations of *perchloric acid* must be performed in a fume hood equipped with wash down facilities. Contact Health, Safety & Environment for fume hood requirements.

### Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the Material Safety Data Sheet. This must occur prior to the use of any oxidizing chemicals. Spill control materials for oxidizers are designed to be inert and will not react with the reagent. *Never use paper towels or other inappropriate materials (which are combustible).* The waste materials generated during spill cleanup may pose a fire risk and must not remain in the laboratory overnight unless they are stored in an appropriate container.

### Vacuum protection

Evacuated glassware can implode and eject flying glass, and splattered chemicals. Vacuum work involving oxidizing chemicals must be conducted in a fume hood, glove box or isolated in an acceptable manner.

Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood.

### Waste disposal

All materials contaminated with oxidizing chemicals pose a fire hazard and must be disposed of as hazardous waste. Alert Health, Safety & Environment if you generate wastes contaminated by oxidizers. Do not let oxidizer-contaminated wastes remain in the laboratory overnight unless proper containers are provided.

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## STANDARD OPERATING PROCEDURES FOR: PYROPHORIC CHEMICALS

Pyrophoric chemicals are liquids or solids that will ignite spontaneously in air at about 130° F.

*Titanium dichloride* and *phosphorus* are examples of pyrophoric solids; *tributylaluminum* and related compounds are examples of pyrophoric liquids.

### Fume hoods

Many pyrophoric chemicals release noxious or flammable gases and must be handled in a hood. In addition, some pyrophoric materials are stored under kerosene (or other flammable solvents); therefore the use of a fume hood is required to prevent the release of flammable vapors in the laboratory. Glove boxes may also be used under certain circumstances (see special ventilation).

### Glove (dry) box

Glove boxes may be used to handle pyrophoric chemicals if inert or dry atmospheres are required.

### Hazard assessment

Hazard assessment for work involving pyrophoric chemicals must thoroughly address the issue of fire safety (including the need for Class D fire extinguishers), proper use and handling techniques, chemical toxicity, storage, and spill response.

### Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of pyrophoric chemicals which pose this risk must occur in a fume hood with the sash in the lowest feasible position.

Portable shields, which provide protection to all laboratory occupants, are acceptable.

### Signs and labels

Containers: All pyrophoric chemicals must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formula and structural formula are not acceptable.

### Special storage

Pyrophoric chemicals must be *stored under an atmosphere of inert gas or under kerosene as appropriate*. Do not store pyrophoric chemicals with flammable materials or in a flammable-liquids storage cabinet. Store these materials away from sources of ignition. Minimize the quantities of pyrophoric chemicals stored in the laboratory.

Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container, which may cause a fire or explosion.

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### **Special ventilation**

Always attempt to handle pyrophoric chemicals in a fume hood or glove box. If your research does not permit the handling of pyrophoric chemicals in a fume hood or glove box, contact the HSE to review the adequacy of all special ventilation.

### **Vacuum protection**

Evacuated glassware can implode and eject flying glass, and splattered chemicals. Vacuum work involving pyrophoric chemicals must be conducted in a fume hood or isolated in an acceptable manner.

Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood. Vacuum pumps must be rated for use with pyrophoric chemicals.

### **Waste disposal**

All materials contaminated with pyrophoric chemicals must be disposed of as hazardous waste. Alert the Health & Safety Office if you generate wastes contaminated with pyrophoric chemicals. These wastes pose a significant fire risk.

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## STANDARD OPERATING PROCEDURES FOR: REACTIVE LIQUIDS

Reactive liquids are liquids that react vigorously with moisture or oxygen or other substances.

### Eye protection

Eye protection must be worn at all times when handling reactive liquids. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the Practice for Occupational and Educational Eye and Face Protection ANSI Z.897.1 1989 and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists, other eye protection and/or face protection must be worn.

### Eye Washes

Where the eyes or body of any person may be exposed to reactive liquids, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use.

### Fume hoods

Many reactive liquids will ignite or liberate ignitable or explosive gases when exposed to water vapor or air. The use of a fume hood is recommended to prevent the buildup of such gases.

### Glove (dry) box

A glove box may be used to handle reactive liquids if an inert or dry atmosphere is required.

### Hazard assessment

Hazard assessment of work involving reactive liquids must address proper use and handling techniques, fire safety (including the need for Class D fire extinguishers), storage, the specific reactive nature of the material (such as water and air reactivity), and waste disposal issues. Consult MSDS for proper hazard assessment.

### Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of reactive liquids that pose this risk must occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

### Safety shower

A safety or drench shower must be available in a nearby location where the reactive liquids are used.

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### Signs and labels

Containers: All reactive liquids must be clearly labeled with the correct English chemical name. Handwritten labels are acceptable; chemical formula and structural formula are not acceptable.

### Special storage

Reactive liquids must be stored in a *cool and dry location*.

*Keep reactive liquids segregated from all other chemicals in the laboratory.* Minimize the quantities of reactive liquids stored in the laboratory.

*Date all containers upon receipt.* Examine storage containers frequently. Dispose of any container that exhibits salt build up on its exterior. Dispose of all reactive liquids whenever they are no longer required for current research or teaching.

Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container that may cause a fire or explosion.

### Special ventilation

Special ventilation may be required if these materials are used outside a fume hood. If your research does not permit the handling of reactive liquids in a fume hood, you should contact the Office of Health & Safety to review the adequacy of ventilation.

### Waste disposal

All materials contaminated with reactive liquids must be disposed of as hazardous waste. Alert Health & Safety if you generate wastes contaminated by reactive liquids. These wastes may pose a fire risk and must remain in the laboratory for as little time as possible.

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## STANDARD OPERATING PROCEDURES FOR: REACTIVE SOLIDS

Reactive solids are chemicals that react vigorously with moisture and other substances. The most common reactive solids include sodium, potassium and lithium metals, acid anhydrides and acid chlorides.

### **Glove (dry) box**

Glove boxes may be used to handle reactive solids if inert or dry atmospheres are required.

### **Signs and labels**

Containers: All reactive solids must be clearly labeled with the correct English chemical name. Handwritten labels are acceptable; chemical formula and structural formula are not acceptable.

### **Special storage**

Reactive solids must be stored in a cool and dry location. Keep reactive solids segregated from all other chemicals in the laboratory. Minimize the quantities of reactive solids stored in the laboratory. Date all containers upon receipt. Potassium will form peroxides and superoxides when stored under oil at room temperature. Examine storage containers frequently. Dispose of any container that exhibits salt build up on its exterior. Dispose of all reactive solids whenever they are no longer required for current research or class work.

Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container, which may cause a fire or explosion.

### **Special ventilation**

Special ventilation is required if these materials are used outside of a fume hood or glove box. If your research does not permit the handling of reactive solids in a fume hood or glove box, you should contact Health & Safety to review the adequacy of ventilation.

### **Waste disposal**

All materials contaminated with reactive solids must be disposed of as hazardous waste. Alert the Office of Health & Safety if you generate wastes contaminated by reactive solids.

These wastes pose a significant fire risk.

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## STANDARD OPERATING PROCEDURES FOR: REPRODUCTIVE HAZARDS

Reproductive hazards are substances which affect reproductive capabilities, including chromosomal damage (mutagens) and have effects on the fetus (teratogens).

### Designated area

The room number sign for the laboratory must contain a “*Designated Areas Within*” identifier.

All locations within the laboratory where reproductive hazards are handled must be posted with designated area caution signs. This includes all fume hoods and bench tops where the reproductive hazards are handled.

Where feasible, reproductive hazards must be manipulated over plastic-backed disposable paper work surfaces. These disposable work surfaces minimize work area contamination and simplify clean up.

### Fume hoods

Manipulation of reproductive hazards must be carried out in a fume hood. If the use of a fume hood proves impractical, refer to the section on special ventilation.

All areas where reproductive hazards are stored or manipulated must be labeled as a designated area.

### Hazard assessment

Hazard assessment must focus on proper handling techniques, education of laboratory workers concerning the health risks posed by reproductive hazards, and the demarcation of designated areas.

### Signs and labels

Doorways: The lab entrance must be posted with a yellow “*Caution*” sign where reproductive hazards are stored or used.

Containers: All containers of reproductive hazards must be clearly labeled with the correct English chemical name. Handwritten labels are acceptable; chemical formulae and structural formulae are not acceptable.

### Special storage

Reproductive hazards must be stored in a designated area.

### Special ventilation

Manipulation of reproductive hazards outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to reproductive hazards in the laboratory and are the preferred ventilation control device. When possible, handle reproductive hazards in a fume hood. If the use of a fume hood proves impractical attempt to

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work in a glove box or on an isolated area of the bench top.

If available, consider using a Biological Safety Cabinet. The biological safety cabinet is designed to remove particulates (the reproductive hazard) before the air is discharged into the environment. *Reproductive hazards that are volatile must not be used in a biological safety cabinet unless the cabinet is vented to the outdoors.*

If your research does not permit the handling of reproductive hazards in a fume hood, biological safety cabinet, or glove box, you should contact HSE at 410-955-5918.

All areas where reproductive hazards are stored or manipulated must be labeled as a designated area.

### **Vacuum protection**

Evacuated glassware can implode and eject flying glass, and splattered chemicals. Vacuum work involving reproductive hazards must be conducted in a fume hood, glove box, where appropriate, or isolated in an acceptable manner.

Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood.

### **Waste disposal**

All materials contaminated with reproductive hazards must be disposed of as hazardous waste. Wherever possible, attempt to design work in a manner that reduces the quantity of waste generated. Questions regarding waste pick up should be directed to the Office of Health & Safety. This office can also assist you in minimizing waste generation.

		Reproductive Hazards*	
Name	CAS#	Name	CAS#
Acetaldehyde	75-07-0	Hydrazine(s)	302-01-2
Arsenic	7440-38-2	Hexafluoroacetone	684-16-2
Aniline	62-53-3	Halothane	151-67-7
Aflatoxins		Karathane	131-72-6
Benzene	71-43-2	Lead (inorganic compounds)	7439-92-1
Benzo(a)pyrene	50-32-8	2-Methoxyethanol	109-86-4
Carbon disulfide	75-15-0	2-Methoxyethyl acetate	110-49-6
Chloroform	67-66-3	Methyl chloride	74-87-3
Chloroprene	126-99-8	N-Methyl-2-pyrrolidone	872-50-4
Dimethyl formamide	68-12-2	Propylene glycol monomethyl ether	107-98-2
Di-sec-octyl-phthalate	117-81-7	Propylene glycol monomethyl ether acetate	108-65-6
Dinitrooctyl phenol	63149-81-5	Propylene oxide	75-56-9
Dithane	111-54-6	Trichloroethylene	79-01-6
2-Ethoxy ethanol	110-80-5	RH-7592	
2-Ethoxyethyl acetate	111-15-9	Systhane/RH-3866	88671-89-0
Ethylene thiourea	96-45-7	TOK (herbicide)	1836-75-5
2-Ethylhexanol	04-76-7	Toluene	108-88-3
Glycol ethers		Vinyl chloride	75-01-4

\*This list is provided as a guide and is not all inclusive. Carefully review Material Safety Data Sheets before working with chemicals.

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## **STANDARD OPERATING PROCEDURES FOR: WATER SENSITIVE CHEMICALS**

Water sensitive chemicals are chemicals that react vigorously with moisture. Some common water sensitive chemicals include sodium, potassium, lithium metals and aluminum alkyls.

### **Eye protection**

Eye protection must be worn at all times when handling water sensitive chemicals. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the American Standard Practice for Occupational and Educational Eye and Face Protection (ANSI Z.87.1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazards exist other eye protection and/or face protection must be worn.

### **Eye Washes**

Where the eyes or body of any person may be exposed to water sensitive chemicals, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use.

### **Fume hoods**

*Many water sensitive chemicals will liberate hydrogen, which is extremely flammable, when they react with water. The use of a fume hood can serve to prevent the buildup of flammable gases.*

### **Glove (dry) box**

A glove box may be used to handle water sensitive chemicals when a dry atmosphere is required.

### **Hazard assessment**

Hazard assessment of work involving water sensitive chemicals must address proper use and handling techniques, fire safety (including the need for Class D fire extinguishers), storage, water reactivity, and waste disposal issues.

### **Safety shielding**

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of water sensitive chemicals which pose this risk must occur in a fume hood, with the *sash in the lowest feasible position*. Portable shields, which provide protection to all laboratory occupants, are acceptable.

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### Safety shower

A safety or drench shower must be available in a nearby location where the water sensitive chemicals are used.

### Sign and labels

Containers: All water reactive chemicals must be clearly labeled with the correct English chemical name. Handwritten labels are acceptable; chemical formulae and structural formulae are not acceptable.

### Special storage

Water sensitive chemicals must be *stored in a cool and dry location. Keep water sensitive chemicals segregated from all other chemicals in the laboratory.* Minimize the quantities of water sensitive chemicals stored in the laboratory.

Date all containers upon receipt. Potassium will form peroxides and superoxides when stored under oil at room temperature. Examine storage containers frequently. Dispose of any container that exhibits salt build up on its exterior. Dispose of all water sensitive chemicals whenever they are no longer required for your work.

Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container, which can represent a significant fire or explosion hazard.

### Special ventilation

Special ventilation is required if these materials are used outside of a fume hood. If your research does not permit the handling of water sensitive chemicals in a fume hood, you must contact Health, Safety & Environment to review the adequacy of all special ventilation.

### Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the Material Safety Data Sheet. This must occur prior to the use of any water sensitive chemicals. Spill control materials for water sensitive chemicals are designed to be inert and will not react with the reagent. Do not put water on the spill.

In the event of a spill, alert personnel in the area that a spill has occurred. Do not attempt to handle a large spill of water sensitive chemicals. Turn off all ignition sources and vacate the laboratory immediately. Call for assistance.

Emergency (Fire or Medical Emergency)                      JHMI 955-4444                      JHU 516-7777

Health Safety & Environment                                      JHMI 955-5918                      JHU 516-8798

Remain on the scene, *but at a safe distance*, to receive and direct safety personnel when they arrive.

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### **Waste disposal**

All materials contaminated with water sensitive chemicals must be disposed of as hazardous waste. Alert Health, Safety & Environment if you generate wastes contaminated by water sensitive chemicals. **These wastes may pose a fire risk** and must remain in the laboratory for as little time as possible.

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**Laboratory Specific  
Standard Operating Procedures**

Instructions: Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific process, chemical or hazard class. Please fill out the form and then print it on your local printer and place in your Chemical Hygiene Plan.

Date: \_\_\_\_\_  
Principal Investigator: \_\_\_\_\_  
Room & Building: \_\_\_\_\_  
Phone Number: \_\_\_\_\_ Email: \_\_\_\_\_

**Section 1: (Check One)**

\_\_\_\_ Process      \_\_\_\_ Hazardous Chemical      \_\_\_\_ Hazard Class

**Section 2:** Describe Process, Hazardous Chemical or Hazard Class. *List all chemicals in the process and describe / list the names of all hazardous chemicals including common name and abbreviations / list chemicals used in the lab.*

**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 PPE and hygiene practices needed. PPE includes gloves, aprons, lab coats, eye protection, etc...*

**Section 5:** 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. List storage requirements for hazardous chemicals involved with the SOP, including specific areas, and policies regarding access to chemicals. Special procedures such as dating peroxide formers are appropriate here.*

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

**Section 7:** 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 must be identified here.*

**Section 8:** 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 9:** Waste Disposal Procedures. *Indicate how waste will be disposed.*

**Section 10:** Material Safety Data Sheet Locations. *Indicate the location of MSDSs for each hazardous chemical used. Also, indicate the location of other pertinent safety information, i.e. equipment manuals, chemical references, etc.*

**Section 11:** Protocol(s). *Insert your laboratory protocol for specific handling practices.*