THE UNIVERSITY OF CHICAGO | Office of Research Safety

University of Chicago Chemical Hygiene Plan 2019

THE UNIVERSITY OF CHICAGO | Office of Research Safety

Chapter I: General Laboratory Information

Principal Investigator

Name:			
Office:		Dept:	
Phone		E-mail:	

Laboratory Locations:

Building	Room Number	Type of Space

Laboratory Personnel

Name	Position	CNET ID

Chapter II: Introduction:

The University of Chicago is committed to the safety of its employees and compliance with local, state, and federal regulations. As required by Occupational Safety and Health Administration in 29CFR 1910.1450, the University of Chicago is providing this Chemical Hygiene Template that is then customized for each laboratory with the addition of general laboratory information, laboratory-specific training, laboratory-specific emergency procedures, and standard operating procedures. The requirements for the safe handling of chemicals outlined in this Chemical Hygiene Plan will be followed by all laboratory personnel.

Definitions:

Action Level- a concentration designated in 29 CFR 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Chemical Hygiene Officer- an employee who is designated by the employer (The University of Chicago), and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan.

Chemical Hygiene Plan- a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in the laboratory.

Hazardous chemical- any chemical which is classified as a physical hazard or a health hazard, a simple asphyxiant, combustible dust, pyrophoric gas, or hazard not otherwise classified.

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 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.

Permissible exposure limits- For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

Personal protective equipment (PPE)- equipment worn by the employee that provide the user protection from a hazard. Common examples include safety glasses, gloves, laboratory coat, and respirator.

Principal Investigators (PIs) and Laboratory Directors- faculty or staff member (s) responsible for research related activities inside a laboratory.

Safety Data Sheets (SDS)- formerly known as material safety data sheets (MSDS), these documents provided by the manufacturer or distributor have been standardized by Globally Harmonized System to include specific safety information. Please see Chapter V: Hazard Communication in Laboratories for more information.

Standard operating procedure (SOP)- an administrative control designed to reduce the risk by providing a written training document. A SOP should contain general laboratory information, hazard information, emergency procedures, guidelines for safe handling and storage, acceptable scale of reaction, and documentation that lab personnel have reviewed it.

Authority and Responsibilities:

Research Safety Policy Committee:

1. Review and approve the Chemical Hygiene Plan Template;
2. Approve research safety related policies.

The Office of Research Safety's Chemical Safety Officers are responsible for:

1. Functioning as the University's Chemical Hygiene Officers;
2. Functioning as the University's liaison with select Local, State, and Federal regulatory agencies (Federal Select Agent Program, Illinois Department of Public Health, National Institutes of Health Office of Biotechnology Activities, etc.);
3. Reviewing, updating, and publishing the University's Chemical Hygiene Plan;
4. Implementing the provisions of the University's Chemical Hygiene Plan;
5. Conducting Research Safety Inspections;
6. Developing and conducting chemical/ laboratory safety training;
7. Providing guidance and acting as a resource to divisions, departments, Principal Investigators, and research personnel.

Environmental Health and Safety (EHS) is responsible for:

1. Functioning as the University's liaison with select Local, State, and Federal regulatory agencies (Occupational Health and Safety Administration, Environmental Protection Agency, Chicago Fire Department, etc.);
2. Advising, coordinating, and maintaining records for hazardous waste;
3. Arranging for area environmental monitoring evaluation and sampling;
4. Advising personnel on the ergonomics in the laboratory;
5. Managing the Respiratory Protection Program at University of Chicago.

Divisions/Departments are responsible for:

1. Ensuring the compliance of their Principal Investigators and Laboratory Directors to institutional research safety policies;
2. Assisting Principal Investigators/ Laboratory Directors with health and safety related needs;
3. Disciplining laboratory personnel who do not follow safety regulations or conduct their work safely.

Principal Investigators and Laboratory Directors are responsible for:

1. The overall responsibility of the health and safety of personnel in their laboratory;

2. Ensuring that laboratory personnel understand and follow the requirements in the Chemical Hygiene Plan, standard operating procedures, and other laboratory rules;
3. Updating or assigning a designee someone to update this Chemical Hygiene Plan Template with laboratory-specific information;
4. Communicating the hazards present in the laboratory and the safe handling of the hazards;
5. Providing or assigning a designee someone to provide and document laboratory-specific training;
6. Providing personal protective equipment appropriate for the hazards in the laboratory;
7. Addressing or assigning a designee someone to address any deficiencies on inspection reports;
8. Facilitating resolution to any safety complaints with assistance from ORS, EHS, and/or department.

Designated Laboratory Safety Contacts (LSC) are responsible for:

1. Working with the Principal Investigator/ Laboratory Director and laboratory personnel in ensuring the knowledge and compliance with the requirements in the *Chemical Hygiene Plan*, standard operating procedures, and other laboratory rules;
2. Assisting the Principal Investigator/Laboratory Director in providing and documenting laboratory-specific training;
3. Serving as a liaison between the Principal Investigator, laboratory personnel, and the Office of Research Safety;
4. Collaborating with the Office of Research Safety for the research safety inspection;
5. Coordinating the response to any deficiencies noted in the Research Safety Inspection Report.

Laboratory Personnel are responsible for:

1. Reviewing and following the requirements in this Chemical Hygiene Plan and other appropriate safety manuals;
2. Follow all verbal and written laboratory rules and instructions;
3. Complete all necessary trainings;
4. Maintaining a safe and uncluttered work area;
5. Developing laboratory-specific standard operating procedures;
6. Conducting risk assessments before working with hazardous chemicals;
7. Utilizing appropriate controls for the work being completed;
8. Obtaining prior approval before conducting research that falls within the scope of prior approvals (Chapter VI);
9. Understanding the capabilities and limitations of the PPE issued to them;
10. Inspecting PPE before use;
11. Consulting with Principal Investigator, designated Lab Safety Contact, or Office of Research Safety when apprehensive about the hazards or risk associated with the work;
12. Notifying (anonymously if preferred) their supervisor, Environmental Health and Safety, or the Office of Research Safety of any unsafe working conditions, accidents, or injuries occurred while in the laboratory.

Chapter III: Health and Physical Hazards of Chemicals:

Chemical exposures can result from inhalation (most common), ingestion, absorption, and injection. While the Chemical Hygiene Plan's main purpose is to prevent exposure, it also is to inform personnel of the effects of a possible exposure and what to do in case you or a colleague is exposed. Below are some

of the health and physical hazards of chemicals. It should be noted than many chemicals can exhibit many types of health and physical hazards.

Health Hazards- chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins (liver), nephrotoxins (kidneys), neurotoxins (nervous system), agents that act on the hematopoietic systems (blood), and agents which damage the lungs, skin, eyes, or mucous membranes. Chemicals can have effects after a single exposure (acute) or after repeating long term exposures (chronic), therefore it is important to minimize any exposure to hazardous chemicals.

Corrosives- cause irreversible damage to living tissue (i.e. skin, eyes, lungs, and mucous membranes). Typically, these will be for substances or solutions with a pH <2 or >11.5, however pH is not the only factor in determining corrosivity. Corrosive chemicals also present a physical hazard as they can corrode metal and other surfaces. Common examples include hydrochloric acid, sodium hydroxide, phenol, and glutaraldehyde. Personnel handling corrosives should implement the appropriate controls to minimize the likelihood of an exposure to a corrosive chemical.

Irritants- cause reversible effect to living tissue (skin, eyes, lungs, and mucous membranes). While irritants are not as hazardous as corrosives, similar care should be taken to avoid their contact.

Sensitizers- cause hypersensitivity and an allergic response following an exposure. Common laboratory sensitizers include nickel, formaldehyde, and latex. Caution to avoid initial exposure to sensitizers should be taken, however if a chemical hypersensitivity develops please contact Office of Research Safety, University of Chicago Occupational Medicine, and your supervisor to discuss ways to further avoid exposure.

Particularly Hazardous Substances- chemicals with certain health hazards that the Occupational Safety and Health Administration (OSHA) has determined additional provisions are required to protect worker safety. Refer to Chapter IV: General Laboratory Hygiene for additional information on how to handle these chemicals. The health hazards that qualify as particularly hazardous substances include carcinogens, reproductive toxins, and substances with a high degree of acute toxicity.

Carcinogens- may cause cancer. There are many different types of carcinogens in terms of regulatory definitions. Select carcinogens are substances that are regulated by OSHA as a carcinogen; listed by the National Toxicology Program (NTP) as either “known to be carcinogens” or “reasonably anticipated to be carcinogens”; or listed by International Agency for Research on Cancer Monographs (IARC) as Group 1, 2A, or 2B. Common examples of select carcinogens include chloroform, cobalt and nickel compounds, formaldehyde, and dichloromethane.

A subset of select carcinogens include regulated carcinogens which are chemicals regulated by OSHA with certain standards such as formaldehyde, benzene, dichloromethane (methylene chloride), and ethylene oxide. OSHA also has “Listed Carcinogens” that are regulated under the 13 Carcinogens standard (29CFR 1910. 1003). These 13 carcinogens have some of the highest restrictions regarding their use, storage, and disposal.

Reproductive Toxicants- can damage to the reproductive system or to a fetus. OSHA defines chemicals that are mutagenic or teratogenic as reproductive toxicants. Some reproductive toxicants found in the laboratory include ethidium bromide, toluene, and lead.

Substances with a High Degree of Acute Toxicity- can cause immediate harm and possible death in the event of an exposure. Median lethal dose (LD_{50}) experiments in animal models are typically reported and used to determine if a chemical has a high degree of acute toxicity. These tests are administered orally, dermally, and via inhalation. Chemicals considered highly toxic have an oral LD_{50} less than or equal to 50mg/ kg for rats, dermal LD_{50} of 200mg/kg when administered by continuous contact for 24 hours to rabbits, or median lethal concentration (LC_{50}) of 200ppm or 2mg/L when administered by continuous inhalation for 1 hour to rats. Common examples include sodium cyanide, hydrofluoric acid, and carbon monoxide.

Physical Hazards- chemicals can have many hazards beyond the ones that directly affect one's health. Classes of physical hazards include flammable, pyrophoric, water reactive, explosive, potentially explosive, compressed gases, oxidizers and corrosives.

Flammables- can readily ignite. For a liquid to be considered flammable its flash point is to be less than 100 degrees Fahrenheit. There are also flammable solids and gases. Flammables should be handled away from ignition sources and with proper ventilation to avoid the concentration of flammable vapors or dust.

Pyrophorics- chemicals that react with the air and ignite. As such special technique or additional engineering controls are required to handle pyrophoric chemicals. While most pyrophorics are liquids or handled in solution there are a number of pyrophoric solids and gases. Common examples of pyrophoric chemicals include tert-butyl lithium, silane, triethylaluminium, and lithium aluminum hydride. These chemicals require very specialized handling techniques which can vary from lab to lab. Please conduct and review laboratory-specific training for handling this class of chemicals.

Water reactive chemicals- chemicals that release either a toxic or flammable gas when in contact with water. Some chemicals react so violently with water that even the humidity in the air can cause a reaction. Laboratory chemicals that are water reactive include lithium, trichlorosilane, and sodium hydride. Laboratory-specific handling and training may be required for the handling of water reactive chemicals.

Compressed Gases- pressurized chemicals typically in metallic cylinders that are ubiquitous in research laboratories. These possess a physical hazard if they were to violently release the contents and pressure. Compressed gasses can also cause asphyxiation or frost bite. Environmental Health and Safety offers a training involving compressed gas cylinders, however a laboratory-specific training may also be needed.

Explosives (Potentially explosive chemicals)- many labs will not be handling explosive chemicals such as trinitrotoluene or black powder, however many labs will handle and store chemicals that may become explosive upon decomposition, polymerization, oxidation, drying out, or some other destabilizing event. A common potentially explosive chemical is picric acid which is extremely sensitive to detonation when it is dried. This is why it is typically sold moistened with water. Also, very common in research labs are peroxide forming chemicals. These chemicals can form explosive crystals after being exposed to air. These chemicals must be dated when they are received when they are open. For disposal requirements please see the hazard class SOP for peroxide forming chemicals.

Oxidizers- can initiate or promote combustion in other materials through a chemical reaction. This chemical reaction can cause a fire or explosion. Oxidizers such as nitric acid, osmium tetroxide, pure oxygen gas or liquid, potassium permanganate, and hydrogen peroxide (concentrations ≥30%) should be

carefully stored and handled to avoid unintentional mixing with flammables or other incompatible chemicals.

Chapter IV: Hierarchy of Controls:

Elimination is the most effective control as it removes the hazard completely. Unfortunately, it is not plausible for most hazards in a laboratory. Most commonly this would include removing a chemical that it no longer uses or eliminating a hazardous process. An example of eliminating a hazardous is to purchase a chemical instead of synthesizing it.

Substitution is also effective at reducing the hazard, by switching the chemical or process with one that is similar. This could mean using a chemical that is less toxic or a form of the chemical that is less hazardous. Common examples would include using SYBR Safe or SYBR Green instead of ethidium bromide for staining DNA gels. Also, another substitution could be the use of lead-free solder which would reduce the risk of lead exposure.

Engineering controls are pieces of equipment designed to reduce the exposure to hazardous chemicals or other research hazards. For hazardous chemicals the most common engineering control is a chemical fume hood.

Fume hoods work by drawing air into the hood through the front sash and out through the top and back of the hood where it is eventually exhausted to the outside. Do not use fume hoods that are alarming or not functioning properly. Fume hoods are to be certified annually to confirm that that they have sufficient flow rates. Only personnel approved by the Office of Research Safety can certify fume hoods. Please contact Office of Research Safety (researchsafety@uchicago.edu) if a fume hood was not certified in the past year. Also see the Fume Hood Guidance Document for more information about fume hoods.

Administrative controls are general rules or instructions designed to minimize possible exposure to hazards. A very effective administrative control for chemical safety is the amount of a chemical allowed or the scale of the reaction. Standard operating procedures, housekeeping, personal hygiene, and emergency preparedness are part of the administrative controls implemented at University of Chicago. As an academic institution we strive to provide the highest-level of education and this extends into the safety training provided. Training is one of the more heavily emphasized administrative controls both at the campus and laboratory level. The Research Safety Policy Council has approved the **Research Safety Education and Training Requirements Policy**. Please refer to the policy for more details.

Campus Required Training: The minimum required training to conduct research or work in a laboratory at the University of Chicago is Chemical Hygiene Plan training and Fire Safety and Evacuation training. These courses have been combined into an in-person Chemical Hygiene Plan – Laboratory Safety course (lab-101) and an online refresher (lab-200). The in-person course is required for all researchers before they begin any research in a laboratory at the University of Chicago (existing researchers who have previously taken CHP training online are exempt). To register for this course please go to https://ehsa.uchicago.edu/trainingregistration. Chemical Hygiene Plan – Laboratory Safety is required annually, but after the initial in person training the online refresher may be completed online at https://ehsa.uchicago.edu/training. For existing resting researchers, it is expected that they will complete the online CHP training in EHSA by January 1, 2020 even if the previous 3-year CHP training hasn't expired. Other trainings are required based on your research and hazards in the laboratory. For

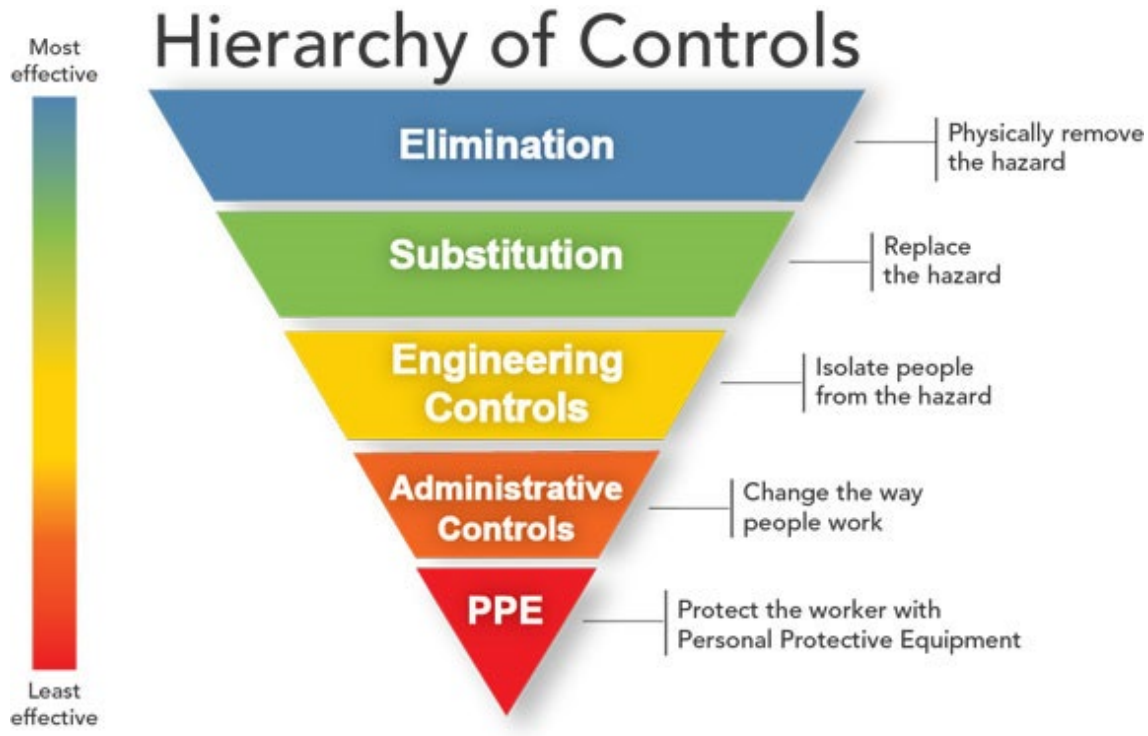
questions regarding campus required trainings please contact Office of Research Safety (researchsafety@uchicago.edu).

Laboratory-Specific Required Training: Each laboratory is different and has different hazards and procedures. As such, it is the responsibility of the Principal Investigator or their designee to provide laboratory-specific training. One example of laboratory-specific training is a laboratory safety orientation. This training is required for all research team members and should be customized based on the Research Personnel Orientation Checklist. Please see Appendix A: Laboratory-Specific Training Requirements and Documentation for additional information and guidance.

Standard Operating Procedures: The Office of Research Safety has provided laboratories with Chapter VIII: General Classes of Hazardous Chemicals Standard Operating Procedures as general use control for the general hazardous chemical classes. For specific chemicals or hazards that exceed the general information provided by this Chemical Hygiene Plan please add SOPs to Appendix B: Laboratory-Specific Standard Operating Procedures. An SOP Template and Guide can be found on our website or by contacting the Office of Research Safety (researchsafety@uchicago.edu).

Other Administrative Controls: include housekeeping, personal hygiene, and emergency preparedness. Chapter VI: General Laboratory Hygiene addresses housekeeping and personal hygiene, whereas Chapter VII: Emergency Procedures and Appendix C: Laboratory-Specific Emergency Procedures captures emergency preparedness.

Personal Protective Equipment (PPE) are items such as respirators, gloves, face shield, eye protection, and chemical splash apron that provide a barrier between the wearer and the hazard. It is the least effective method of hazard control as it is highly dependent on the user to make sure it fits properly, is in good working condition, and is compatible with the hazards present. As such laboratory workers should always consider engineering and administrative controls first while using PPE that is appropriate for the hazards present. Please refer to the Research Safety Policy Council's **Personal Protective Equipment (PPE) Policy** or contact Office of Research Safety (researchsafety@uchicago.edu) if you have questions.

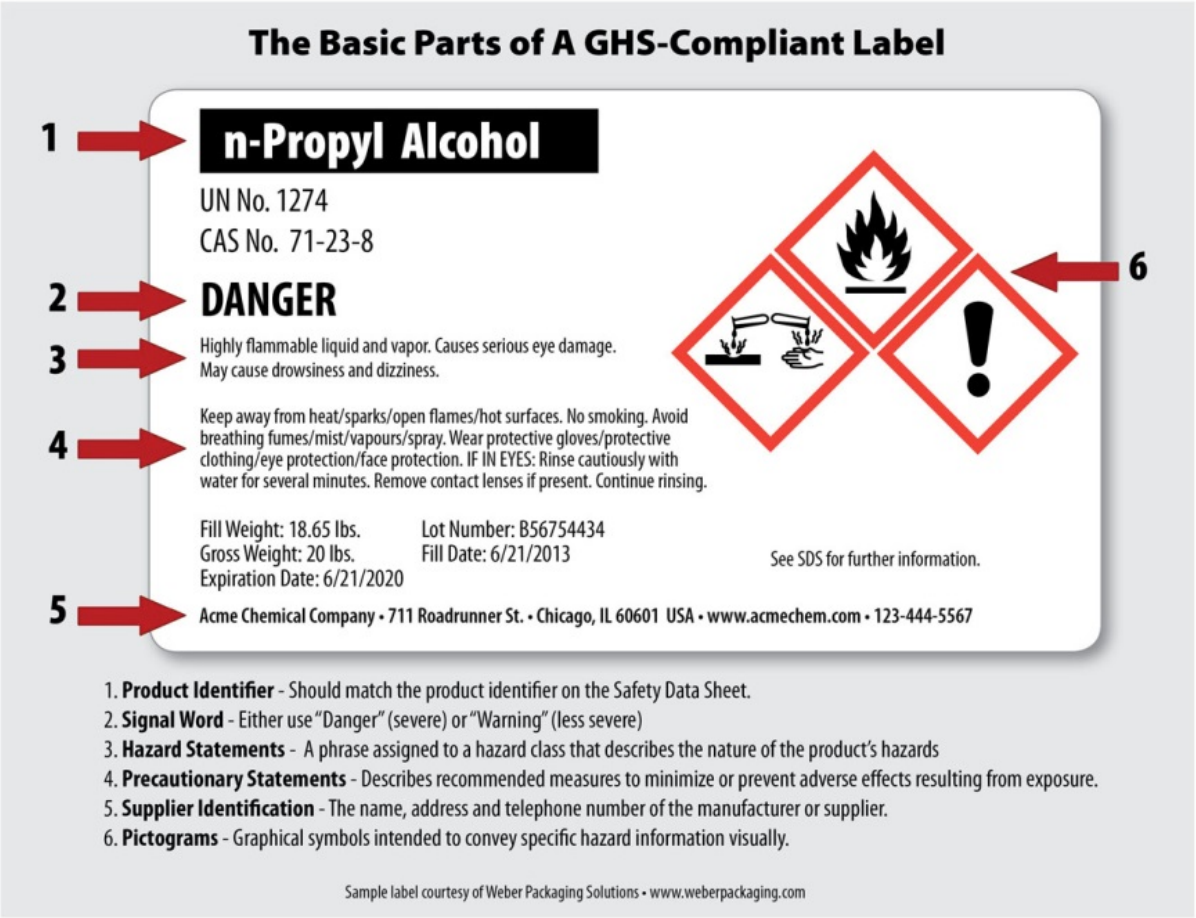


Chapter V: Hazard Communication in Laboratories:

The effective communication of hazards present in the laboratory is not only necessary for the safety of the researchers, but also for the safety of the support staff and emergency personnel. While laboratories are technically excluded from OSHA's Hazard Communication Standard (29CFR 1910.1200) the safety information on commercially obtained chemical bottles and safety data sheets follow this standard and the updated Globally Harmonized System of Classification and Labeling of Chemicals (GHS). Therefore, knowing GHS labeling systems and Safety Data Sheet layout will help with the hazard identification. Also, most of the University's support staff and emergency personnel are trained on Hazard Communication and GHS so their use will be emphasized and encouraged.

Labels

All chemical containers must be labeled with the chemical contents and hazards associated with the chemical. It is important that the label is legible. Chemicals purchased from commercial vendors will have a GHS compliant label which should not be removed until the container has been emptied and sufficiently rinsed. The elements that makes a label GHS compliant is described in the figure below.



In the GHS compliant label, you will notice GHS utilizes pictograms to communicate the different health hazards. These pictograms can be found on many other documents and warnings that describe chemical hazards. Please refer to the figure below that has the GHS approved pictograms and their meaning.

Health Hazard	Flame	Exclamation Mark
		
• Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	• Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non-Mandatory)

Gas Cylinder	Corrosion	Exploding Bomb
 • Gases Under Pressure	 • Skin Corrosion/Burns • Eye Damage • Corrosive to Metals	 • Explosives • Self-Reactives • Organic Peroxides
Flame Over Circle	**Environment** (Non-Mandatory)	**Skull and Crossbones**
 • Oxidizers	 • Aquatic Toxicity	 • Acute Toxicity (fatal or toxic)

For containers of chemicals that have been transferred from a commercial vendor's container, the lab should include the name and hazards of the chemical. An example of this is transferring acetone from a vendor's container to a wash bottle. See figure below for an illustrative example.

Chemicals synthesized in the laboratory might not be easily labeled with the name and hazard. In these cases, the lab should develop a systematic way to label in which personnel in the lab can easily identify the chemical and hazards. A recommended method is to have the user's initials, a notebook page number where additional information on the compound could be found, and any known hazards.

For chemical substances that are produced for another user outside of the laboratory, the laboratory shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of safety data sheets and labeling.

Inventory

Every laboratory is required to have an updated and accurate chemical inventory. Chemical inventories must be updated and verified to be accurate by the Principal Investigator or designee at least once a year. Currently ORS and EHS provide laboratories access to EH&S Assistant to upload, update, and verify

their chemical inventories. Some labs have found other software, such as Quartzy, as a useful inventory program. At minimum, the lab should maintain an up to date chemical inventory locally and present to ORS when requested. Please refer to the Chemical Inventory Guidance Document or contact Office of Research Safety (researchsafety@uchicago.edu) for questions.

During the annual chemical inventory review please submit a disposal request for any aging/unstable chemicals, specifically peroxide forming chemicals (See page 34 for more information).

Safety Data Sheets (SDS)

Every chemical in the laboratory must have a safety data sheet available. These documents are prepared by the chemical manufacturer and have been standardized with GHS. Typically, labs will have electronic access to SDS, however ORS strongly encourages labs to have hard copies available for the lab's most hazardous chemicals.

The University of Chicago allows labs to access Safety Data Sheets from EHS Assistant (https://ehsa.uchicago.edu/).

Below are the different sections as required by GHS.

Section 1, Identification includes product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use.

Section 2, Hazard(s) identification includes all hazards regarding the chemical; required label elements.

Section 3, Composition/information on ingredients includes information on chemical ingredients; trade secret claims.

Section 4, First-aid measures includes important symptoms/ effects, acute, delayed; required treatment.

Section 5, Fire-fighting measures lists suitable extinguishing techniques, equipment; chemical hazards from fire.

Section 6, Accidental release measures lists emergency procedures; protective equipment; proper methods of containment and cleanup.

Section 7, Handling and storage lists precautions for safe handling and storage, including incompatibilities.

Section 8, Exposure controls/personal protection lists OSHA's Permissible Exposure Limits (PELs); ACGIH Threshold Limit Values (TLVs); and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the SDS where available as well as appropriate engineering controls; personal protective equipment (PPE).

Section 9, Physical and chemical properties lists the chemical's characteristics.

Section 10, Stability and reactivity lists chemical stability and possibility of hazardous reactions.

Section 11, Toxicological information includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity.

Section 12, Ecological information*

Section 13, Disposal considerations*

Section 14, Transport information*

Section 15, Regulatory information*

Section 16, Other information, includes the date of preparation or last revision.

Laboratory Safety Placards (Door signs)

All laboratory doors that have access to a main corridor are to have a laboratory safety placard printed from EH&S Assistant (https://ehsa.uchicago.edu). The laboratory is responsible for making sure that the laboratory safety placard has the correct hazards indicated and up to date with the lab's emergency contact information. During the annual chemical safety inspection, ORS will review the laboratory safety placard for each room and may require labs to update if errors or deficiencies are found.

Chapter VI: General Laboratory Hygiene

Housekeeping

Often laboratories will have numerous researchers and will require the sharing of common chemicals and equipment. As such it is good to establish, communicate, and document laboratory-specific rules that extend beyond those highlighted in this Chemical Hygiene Plan. The rules and suggestions discussed here are for safety and compliance.

- Keep all aisles, doorways, and areas around emergency equipment (safety eyewash, safety shower, fire extinguishers) clear. In case of an emergency, personnel will need to safely evacuate or have access to emergency equipment.
- Flush your safety eyewash for 3 minutes monthly (weekly recommended) and document on an eyewash log sheet. Flushing the eyewash removes any sediment or microbial growth in the line and ensures that it is functioning properly. Some common problems include low pressure, persistently discolored water, extreme cold or hot water temperature, the area not being accessible, proximity to hazardous chemicals, and electrical equipment too close. It is better to discover these problems before an emergency than during one!
- Chemicals should be stored in appropriate cabinets and designated storage rooms. This will allow laboratory workers to easily find chemicals, prevent incompatible storage, and maintain compliant volumes of chemicals. Storage of corrosive chemicals on upper shelves is restricted to prevent accidental exposure to the eyes. All chemical storage above eye level should be discouraged.
- Secondary containers made from a chemically compatible material (i.e. plastic tubs) are to be used to store corrosives, particularly hazardous substances, and liquid hazardous wastes. Secondary containers are also suitable to segregate incompatible chemicals. These containers should be able to hold at least 110% of the volume of the largest container in case of spill or bottle breakage.
- Refrigerators or freezers storing flammable chemicals must be UL Listed as being acceptable for the storage of flammables. Any refrigerators or freezers in the laboratory not UL Listed as acceptable for the storage of flammables should have a sign indicating "No Flammable Storage." Also, no food or drink is permitted inside the laboratory refrigerators or freezers unless it is clearly labeled "Not for Human Consumption." Laboratory-use ice machines should also clearly be labeled "Not for Human Consumption."
- Laboratory workers should keep their benches and work spaces (including fume hoods) clean and clear of excessive clutter. There should be no sign of spill or contamination present. Clean benches and workspaces minimize the possibility of contamination of personnel and experiments. Excessive clutter can also be a research quality and safety issue. Excessive storage in fume hoods can impede the air flow and should be avoided.
- Remove gloves before leaving the lab or when working on computers where glove usage is not universally followed. Cross-contamination from gloves touching commonly used items such as

door handles, and elevator buttons is unacceptable. An appropriate method when going between labs is to take one glove off and using the ungloved hand for items such as door handles and elevator buttons.

- Keep an accurate inventory and review it at least annually. Annual review can discover chemicals that can become unstable over time before they become extremely hazardous (and expensive) to handle. Annual inventory can also promote the disposal of chemicals no longer needed. Inventories are important for the lab and can prevent costly purchases of chemical already in their possession. Storage of extra chemicals becomes difficult as laboratory space is limited.
- When possible purchase in small quantities. Ordering larger quantities of a chemical than needed causes difficulty finding an acceptable storage location and might lead to the expiration or deterioration of a chemical.

Personal Hygiene

When working in a laboratory personal hygiene is very important. Lab personnel should always wash their hands after handling chemicals, before leaving for lunch, and at the end of the workday. Long hair and loose clothing should be confined to prevent accidental contamination or entanglement. Labs should not have any food or drink stored and absolutely no consumption of food or drink is allowed. Even the appearance of eating or drinking in the lab is prohibited. Finally, cosmetics including lotion and lip balm should not be used in the laboratory.

Hazard and Risk Assessment

Laboratory personnel should be able to assess the hazards and risks associated with their work. For chemicals, hazards are the inherent danger of the chemical or process. Risk is the likelihood of a hazard causing harm. Chemical experiments should have hazard and risk assessments completed and documented appropriately such as in a laboratory notebook. A common mistake made by both inexperienced and experienced researchers is to underestimate the risk. Please be mindful of this tendency.

Chemical hazards are discussed in Chapter III: Health and Physical Hazards of Chemicals and safe handling practices are covered in Chapter VIII: General Classes of Hazardous Chemicals Standard Operating Procedures. Since the hazard is inherent to the chemical and the process used the only way to minimize the hazard is to eliminate or substitute it for a less hazardous one as described in Chapter IV: Hierarchy of Controls. Risk however is a probability; therefore, it can be minimized to acceptable levels. Also, described in Chapter IV are ways to mitigate the hazard to reduce the risk. With chemicals a very easy, effective, and practical way to reduce risk is to use a smaller scale.

Transporting Chemicals

Chemicals may have to be transported from one laboratory to another or picked up from a stockroom. Always transport chemical containers in an appropriate secondary container to prevent the spread of a leak or spill. Do not transport incompatibles inside the same secondary container. Labs should use a non-metal cart that has lips on all four sides for spill prevention when transporting larger quantities of chemicals. Proper PPE including eye protection, lab coat, and gloves should be in possession when transporting chemicals.

Chemical Storage

Chemicals must be stored safely and properly to prevent accidental mixing, adverse reactions, and the spread of fire in an emergency. Proper chemical storage first involves the segregation of incompatible materials. Common incompatibles include flammables with oxidizers, acids with bases, inorganic acids with organic acids, and water reactive chemicals with aqueous solutions and alcohols. Please review the chemical Safety Data Sheet for specific incompatibilities. Incompatibles can be segregated by use of a secondary container (i.e. plastic tub). The secondary container should be chemically compatible and be able to hold 110% of the largest container. Chemicals should not be stored on the ground without secondary containment and away from where they can become a trip hazard.

For storage requirements of specific chemical classes please refer to Chapter VIII: General Hazard Class Standard Operating Procedures. Chemical-specific storage requirements can be found by referencing the chemical's Safety Data Sheet. Additional information can be found on the Chemical Storage and Segregation Guidance Document. Please contact Office of Research Safety (researchsafety@uchicago.edu) with questions or concerns.

Handling Chemicals

Before chemicals are handled, laboratory personnel should have completed all required training, read this Chemical Hygiene Plan, and conducted a risk assessment for the use of the chemical. The risk assessment should evaluate the need and proper usage of engineering controls, administrative controls, and PPE. It is encouraged that this risk assessment is documented in a laboratory notebook or other written procedure. For handling requirements of specific chemical classes please refer to Chapter VIII: General Hazard Class Standard Operating Procedures. Chemical-specific handling requirements can be found by referencing the chemical's Safety Data Sheet. Please contact Office of Research Safety (researchsafety@uchicago.edu) with questions or concerns.

Prior Approval

Certain research activities require prior approval before lab personnel are allowed to continue. Prior approvals vary from requiring the Principal Investigator to sign off or can require a committee approval. While not completely comprehensive below is a list of activities that will require prior approvals and the authorizing person(s) for evaluating the safety around that activity. Any questions should be directed to ORS (researchsafety@uchicago.edu).

Work with/includes:	Authorizing Person(s):
Animals (vertebrates)	IACUC/ARC
Purchase, relocation or decommissioning of a Biological Safety Cabinet	Biosafety Office
Shipping and receiving biological material	Biosafety Office, URA
Human or non-human primate derived material	Biosafety Office
Microorganisms that are pathogenic to humans, plants, or animals	IBC
Transactive peptides, and infectious proteins	Biosafety Office/IBC
Recombinant DNA	IBC
Genetic modification of organisms	IBC
Biological toxins (LD50<25ug/kg or regulated by the Federal Select Agent Program)	IBC
Class 3b or 4 lasers	Laser Safety Office/ Radiation Safety Office

Radioactive material	Radiation Safety Office/ Radiation Safety Committee
X-ray instrumentation	Radiation Safety Office
Shipping and receiving RAM	Radiation Safety Office
Any activity prohibited in the CHP	Chemical Safety Office
Highly toxic gases	Chemical Safety Office
Corrosive gases	Chemical Safety Office
Pyrophoric gases	Chemical Safety Office
Ethylene Oxide sterilizer	Chemical Safety Office
Reactions likely to cause an explosion hazard	Chemical Safety Office
Pressure reactors exceeding 15psig and/or 100mL	Chemical Safety Office
Transfilling of compressed gases	Chemical Safety Office
Experiment that exceed “laboratory scale”	Chemical Safety Office
Use of a respirator	Chemical Safety Office/ EHS
Transporting chemicals off campus	Chemical Safety Office
Installation or modification of a chemical fume hood	Chemical Safety Office
Inactivation of a chemical fume hood	Chemical Safety Office
Laboratory renovations	ORS
Laboratory commissioning/decommissioning/ relocations	ORS
Educational Assignment for minors and volunteers in a laboratory	ORS (See PolicyU610)
Restarting a procedure that resulted in an injury or illness	ORS
Drain disposal of chemicals	EHS
Work with Particularly Hazardous Substances	Principal Investigator
Working alone/ afterhours work (7pm-7am)	Principal Investigator
High hazard operations as determined by PI	Principal Investigator
Unattended/overnight reactions	Principal Investigator

Laboratory Safety Equipment

Due to the hazards and risk associated with research, emergency safety equipment is found in the laboratory. Lab personnel are responsible for knowing the location and safe operation of the laboratory’s safety equipment. Below is some common safety equipment. For additional information please refer to the Emergency Safety Equipment Guidance Document or contact the Office of Research Safety (researchsafety@uchicago.edu).

- Emergency showers are for the immediate rinsing and flushing of hazardous chemicals or can extinguish fire on a person. At minimum an annual inspection of safety showers is required. Please contact your Building Manager if this has not been completed or if you have concerns.
- Emergency eyewashes are for the immediate rinsing and flushing of hazardous chemicals from one’s eyes. Laboratories are required to flush monthly (weekly recommended) and maintain documentation regarding this flush.
- First aid kits should be accessible, and their location known to laboratory personnel. The contents of the kit should be consistent with the hazards in your laboratory. Items should be in good condition and unexpired. Common supplies should include bandages, burn cream,

antiseptic ointment, exam gloves, absorbent compress, and tape. Special hazards such as hydrofluoric acid will require calcium gluconate gel and biohazards require disinfectant rinse agent (i.e. 3% hydrogen peroxide or a povidone-iodine solution).

- Chemical spill kits can be for an individual lab or shared amongst labs, however each laboratory is responsible for making sure its contents are appropriate for the chemicals in their inventory. Typical chemical spill kits will include absorbents, acid neutralizers, caustic neutralizers, pH paper, safety glasses/ goggles, chemical resistant gloves, disinfectant, plastic bags, broom, and dust pan. Certain chemicals such as hydrofluoric acid, formaldehyde, and mercury will have additional supplies needed for a spill response.
- Fire extinguishers are required to be present in all laboratories and the type of extinguisher should be appropriate for the fire hazard present. They should only be used for small fires where the user is trained on the PASS method and comfortable using it.

Use of Hazardous Chemicals in Animal Research

At the University of Chicago, several studies are conducted using hazardous chemicals with animal models. This may be the use of novel or experimental compounds to discover treatments to disease or can be standard chemicals typically used in veterinary care. Protocols involving the use of animals in research require an Animal Care and Use Protocol be submitted to the Institution Animal Care and Use Committee (IACUC). The use of hazardous chemicals must be included in this protocol. Animal Resource Center (ARC) and IACUC may have additional requirements for the type, usage, training, and designated areas for hazardous chemical usage in animals.

There are several considerations that must be analyzed when using hazardous chemicals in animals that are unique to animal research. First, many drugs or chemicals must be prepared prior to delivery into the animal. Common preparations include dissolving, dilution, milling and mixing. The preparation of hazardous chemicals for administration into animals should be conducted in the laboratory and never in the Animal Resource Center (ARC, 773-70**2-6756,** https://animalresources.uchicago.edu/). It should follow the requirements and recommendations in this Chemical Hygiene Plan regard the use of engineering controls, administrative controls, and personal protective equipment. Please contact Office of Research Safety (researchsafety@uchicago.edu) with questions or concerns.

Next, laboratory personnel have to consider how the compound is being delivered to the animal. Different delivery methods can expose the personnel performing the administration to a higher risk. The risk of injection is of major concern and should be addressed by anesthetizing or properly restraining the animal. ARC veterinarian staff will be able to assist with any questions. In addition to injection the use of anesthetic gases presents a possibility for inhalation exposure. Proper scavenging systems should be used to minimize this risk. Please contact Office of Chemical Safety or ARC with questions on scavenging equipment and training.

Another safety consideration is what happens to the chemical once it is in the animal, how is it metabolized, what is its metabolic product, and eventually how is it excreted or shed. Some chemicals are metabolized into nonhazardous or lower hazardous byproducts. Occasionally chemicals are metabolized into more hazardous chemicals. If the compound or metabolites are unknown, then they should be assumed to be hazardous and fully excreted.

Once these hazardous agents are excreted, they can contaminate the bedding and cages. While researchers typically are not responsible for the cage changes, workers who do perform these tasks rely on you for accurate information so the hazards and risk can be communicated and controlled. It is the

researcher's responsibility to fully describe the research in their protocol particularly the use of hazardous chemical. Researchers must follow ARC rules regarding the administration of chemicals, labeling cages with the appropriate hazard, housing the animals in approved locations, and caging of the animals.

Working Alone in the Lab

Working alone implies that another person cannot respond with immediate assistance in the event of an incident, accident, or emergency. Laboratories are potentially hazardous places to work. As such working alone in a laboratory with hazardous chemicals or equipment is strongly discouraged by the University and can be prohibited by the Department, Laboratory Director, or Principal Investigator. It is the right of the researcher to refuse to carry out experimental procedures while working alone.

If work is to be conducted alone, it is the responsibility of the researcher to:

- inform and obtain prior approval from the supervisor that they will be working alone;
- describe the scope of this work;
- assess the risks associated with the experimental work;
- take the precautions to mitigate the risk;
- review the emergency response.

In agreement with the *Minors In Educational Assignments in Laboratories* policy, people under the age of 18 years-old must be directly supervised at all times while in a research laboratory, either by the PI/supervisor or a designee.

Exposure Monitoring

Exposure monitoring is supported by Environmental Health and Safety office. The use of certain chemicals may require periodic exposure monitoring. Also, some medical conditions will warrant exposure monitoring. Employees are given the right to observe the testing, sampling, monitoring, or measure of employee exposure as well as given the opportunity to review the results and discuss them with a medical professional.

All laboratory personnel who have been or believe they may have been exposed to a hazardous chemical have the right to receive an employer-provided medical examination. This examination is at no cost to the employee or student. Employees should either go to University of Chicago Occupational Medicine (UCOM, D-136) or the Adult Emergency Room for emergency or after-hours care. Students can go to the Student Health Services (R-100) or Adult Emergency Room for emergency or after-hours care. Please see Chapter VII: Emergency procedures for more information or contact the Office of Research Safety.

Hazardous Waste

Environmental Health and Safety has released the Hazardous Waste and Disposal Procedures Policy. Below is a summary and useful instructions to assist with the laboratory's hazardous waste disposal. Questions regarding the disposal of hazardous waste should be directed to Environmental Health and Safety (773.702.9999, safety@uchicago.edu).

Hazardous chemical waste must be collected in containers appropriate for the waste, properly labeled, and picked up by the University's hazardous waste disposal contractor. Due to strict waste regulations, only the vendor currently under contract with the University is legally allowed to remove waste from

this campus. Pouring hazardous waste down the drain is prohibited and prior approval from EHS is required for the disposal of any laboratory chemical.

Waste collections occur each week on Thursday for campus labs that submit a request by Wednesday before 3:00pm. Laboratories in the hospital buildings have pickups on Wednesday and must submit the request by Tuesday at 3:00pm.

On-line Request: Submit an on-line request through the EH&S Assistant Program (https://ehsa.uchicago.edu). In an effort to efficiently collect waste the use of the EH&S Assistant program is strongly encouraged. However, if necessary, labs can submit a waste pick-up by contacting Environmental Health and Safety, 773.70**2.9999** (safety@uchicago.edu).

In an effort to comply with the Environmental Protection Agency's (EPA's) waste minimization policy the University must document efforts to reduce hazardous wastes in the laboratory. It is the responsibility of each PI who generates waste to incorporate the principles of waste minimization into their research activities.

- Limit the amount of chemicals purchased. Purchasing the bulk quantity may be cheaper on the front end, but the disposal costs and environmental impact need to be considered;
- If feasible, substitute less hazardous chemicals;
- Avoid generating "unknown" substances. Properly label the waste container to clearly convey the contents in the bottle to assist the waste disposal vendor in their waste profile and testing;
- If you order excess chemicals or your inventory is exceeding your needs, attempt to share inventory items with your fellow PI's.

Empty chemical containers can be disposed after they have been triple rinsed with water, the container label defaced, and there is no sign of chemical residue. If the previous contents were highly toxic or the chemical is on the EPA Acutely Hazardous Waste "P" List collect the rinse water and dispose the wash as hazardous waste. A link to the EPA's "P" List is available on Environmental Health and Safety's Hazardous Waste and Disposal Procedures Policy. Empty bottles can also be used to collect hazardous waste if it is compatible with the waste. The University's hazardous waste disposal vendor can provide additional containers to collect waste. Contact Environmental Health and Safety (773.70**2.9999**, safety@uchicago.edu) for information.

Broken glassware that is not contaminated with hazardous chemicals, biohazards, or radioactive sources can be disposed by packing in a lined cardboard or other rigid container and taped. Disposal of broken glass containers and empty (triple rinsed) chemical containers are removed from the lab differently depending on the building. Please contact your Building Manager for details.

Chapter VII: Emergency Procedures

Campus-wide Contacts

University of Chicago Police:	**123 from campus phone OR** 703.70**2.8181**
UChicago Adult Emergency Room	773.70**2.6250**

Poison Control	**800.222.1222**
Office of Research Safety	773.83**4.2707** researchsafety@uchicago.edu
Radiation Safety	773.70**2.6299** radsafety@uchicago.edu
Environmental Health and Safety	773.70**2.9999** safety@uchicago.edu
ARC Emergency hotline	773.70**2.1342**
UChicago Hospital Safety	773.79**5-7233** safety@uchospitals.edu
Needle Stick hotline	773.75**3.1880 pager 9990#**
UCOM	773.70**2.6757** **D-136**
Student Health Services	773.70**2.4156** **R-100**

Campus-wide Procedures

Fire (or Smoke):

In the case of fire or smoke you will need to know the acronym RACER.

R= Rescue, move persons away from immediate area

A= Alarm, activate the fire alarm pull station, call UChicago Police (123 or 773.702.8181)

C= Contain, close doors and windows

E= Extinguish, only if safe to do so with the appropriate fire extinguisher. Use the **PASS** method: **P**ull, **A**im, **S**queeze, **S**weep

R= Relocate, evacuate safely and muster outside the building

Other key notes:

Know the location of fire alarm pull stations, extinguishers, exit routes, and assembly locations. Do not use the elevators.

In addition to providing the emergency phone operator with emergency information, attempt to meet with first responders to communicate important information.

Maintain proper housekeeping to allow for clear path of egress and to prevent the spread of the fire.

Chemical Spill:

In the event of a chemical spill first determine the nature of the incident to determine if it is safe to clean up. Some chemical spills can be contained and cleaned by the laboratory personnel that are properly trained to work with chemicals.

Chemical spills **SHOULD NOT** be cleaned by the laboratory if:

- More than one chemical spilled
- The quantity is greater than one liter
- The chemical is highly toxic

- The chemical is highly flammable or explosive
- The substance or hazards are unknown
- You are not comfortable with the cleaning procedure

If the lab determines they **CAN** clean the spill they should:

- Refer to the Safety Data Sheet
- Don the appropriate PPE
- Pick up any broken glassware with tongs or brush and dustbin
- For liquid spills, choose an appropriate neutralizer or absorbent
    - General Acids: sodium bicarbonate
    - General Bases: citric acid
    - General Absorbents: vermiculite
- Start from the outside and work towards the center of the spill
- Sweep up the material and dispose all the material into a leak proof bag or container
- Label and dispose bags and containers as hazardous waste
- Labs can contact Chemical Safety 773.834.2707 or the Divisional Lab Safety Specialist if they have questions for spills they can clean.

For spills that the lab **CANNOT** clean:

- Contact UChicago Police by calling **123 (from a campus phone) or 773.702.8181**
- Alert others in the area
- Evacuate the area
- Communicate conditions to first responders

Spill on body/clothes:

- Alert others around you
- Remove contaminated clothing
- Rinse with water for at least 15 minutes
- If on fire, go to the nearest safety shower or stop, drop, and roll.
- Seek appropriate medical attention and notify your supervisor

Spill in eyes:

- Alert others around you
- Proceed to the nearest emergency eyewash
- Rinse eyes for a minimum of 15 minutes
- Seek appropriate medical attention and notify your supervisor

Ingestion:

- Alert others
- Seek appropriate medical attention and notify your supervisor

Inhalation:

- Alert others
- Evacuate to fresh air
- Seek appropriate medical attention and notify your supervisor

Injection:

- Alert others

- Wash affected area with antiseptic soap and water for 15 minutes
- Contact the Needle Stick hotline at 773.75**3.1880 pager 9990#** and notify supervisor

Injury or Exposure:
For any life-threatening injury or exposure, call UChicago Police at **123 (from a campus phone) or 773.702.8181** or seek immediate treatment at the University of Chicago Adult Emergency Room. For non-life-threatening injuries and exposures during normal business hours, employees can go to UCOM (773.702.6757). Students should go to Student Health Services (773.702.4156). Outside business hours please go to University of Chicago Adult Emergency Room.

Other notes:
- Alert your supervisor as soon as possible.
- Supervisors will need to alert their HR Partner and Environmental Health and Safety.
- Do not leave an injured person alone; use the buddy system when traveling to get medical attention or flushing chemicals in a safety shower/eyewash.

Other events: Please refer to EH&S Emergency and Quick Reference Guides (https://safety.uchicago.edu/tools) for other emergencies not covered by the Chemical Hygiene Plan or how to respond to events that occur outside a laboratory.

The University of Chicago's Department of Safety and Security can also be a useful reference and provide notification of campus emergencies with their cAlert system as well as UChicago Safe Mobile Safety App.

Laboratory-specific procedures: Different laboratories will have different chemicals, equipment, and other research instrumentation that may require a specific emergency response in case of a fire, injury, weather event, power outage, or other unexpected event. As such, labs should plan appropriately for such events and document their specific emergency procedures. Please refer to Appendix C: Laboratory-Specific Emergency Procedures for instructions on how to prepare such a document to add the laboratory's emergency procedure.

Chapter VIII: General Hazard Class Standard Operating Procedures

The following SOPs represent best practices and provide a broad overview of the information necessary for the safe operation of laboratories that utilize potentially hazardous chemicals and other physical hazards found in the lab. It is not intended to be all-inclusive. It is important to note that many chemicals have numerous hazards associated with them. Always refer to a chemical's Safety Data Sheet (SDS) and consult the PI and/or the Office of Chemical Safety if you have questions. Please refer to Chapter VI: General Laboratory Hygiene for additional general rules for working in a chemical lab.

Departments, divisions or other work units engaged in work with potentially hazardous chemicals that have unusual characteristics or are otherwise not sufficiently covered below must supplement the CHP with their own SOPs. Please contact the Office of Research Safety (researchsafety@uchicago.edu) with questions or for a SOP Template and Guide.

FLAMMABLE AND COMBUSTIBLE LIQUIDS

HAZARD CLASS DESCRIPTION

Flammable and combustible liquids can ignite and cause severe burns or death. Flammable liquids are defined as having a flash point below 100 ºF and combustible liquids have a flash point between 100-200 ºF. These liquids have a variety of uses inside a laboratory as solvents, reagents, and cleaning solutions. Some flammable and combustible liquids require chemical- or process-specific SOPs. Please contact the Office of Research Safety (researchsafety@uchicago.edu) if you have questions.

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to prevent the accumulation of flammable or combustible vapors and maintain exposure below any regulatory and lower explosive limits. Trace amounts of flammables can be used in Biosafety Cabinets ducted to building ventilation system. Never manipulate flammable or combustible liquids in recirculating Biosafety Cabinets.
- Some flammable and combustible liquids that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

ADMINISTRATIVE CONTROLS

- Do not heat flammable liquids with an open flame.
- Avoid ignition sources such as (but not limited to) heat guns, static electricity, Bunsen burners, etc.
- Avoid using equipment with exposed wiring.
- If metal containers are used, ensure that they are properly grounded.
- Fire extinguishers should be readily available.
- Wash hands thoroughly after handling flammable and combustible liquids.

PPE

- At minimum long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle flammable or combustible liquids.
- Flame-resistant laboratory coats should be worn when working with flammable liquids in amounts that pose a greater than de minimus risk as determined by a risk assessment or when any amount is used near an ignition source.
- Protective gloves that are appropriate for the chemical being handling must be worn
- Additional PPE may be required if the chemical has additional hazards associated with it.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Flammables must be used in well ventilated areas to help prevent the buildup of flammable vapors.
- Thoroughly wash hands after handling.
- Flammable storage cabinets must be used in areas where combined volumes of flammables are greater than **10 gallons (**approximately 40 liters).
- Only the amounts needed for the current procedure should be kept on bench tops.
- Packing material and other combustible materials should be discarded and kept away from flammable and combustible liquids.

- Refrigerators and freezers storing flammable liquids must be designed to store flammable liquids with all electrical equipment that meets the requirements for Class I, Division I Electrical Safety Code (NPFA 45 and 70).
- Flammable and combustible liquids must be kept away from oxidizers and other incompatible materials.
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE
Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL
Decontaminate bench, fume hoods, and other equipment while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult the SDS.
Waste can be collected in a chemically compatible container, labeled, and disposed of by submit an on-line request through the EH&S Assistant Program.

OXIDIZERS

HAZARD CLASS DESCRIPTION
An oxidizer is a chemical that initiates or promotes the combustion in other materials. This can either cause fire itself or through the release of oxygen or other gases. Many chemicals are classified as oxidizers and have multiple uses in the laboratory. Some oxidizers require chemical- or process-specific SOPs. Please contact the Office of Research Safety (researchsafety@uchicago.edu) if you have questions.

ENGINEERING/VENTILATION CONTROLS
- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits. Trace amounts of oxidizers can be used in Biosafety Cabinets ducted to building ventilation system. Never manipulate oxidizers in recirculating Biosafety Cabinets.
- Some oxidizers that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

ADMINISTRATIVE CONTROLS
- Containers should be in good condition and compatible with the material.
- Obtain prior approval from the PI and/or the Office of Chemical Safety before mixing oxidizing agents with flammable or combustible materials.
- Fire extinguishers should be readily available.
- Wash hands thoroughly after handling oxidizers.

PPE
- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle oxidizers.
- Protective gloves that are appropriate for the chemical being handling must be worn.

- Flame-resistant laboratory coats should be worn if mixing oxidizing agent with flammables or combustibles.
- Depending on risk assessment a face shield and/or blast shield may be appropriate.
- Additional PPE may be required if the chemical has additional hazards associated with it.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Store away from flammable and combustible materials.
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and other equipment while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult the SDS.
Waste can be collected in a chemically compatible container, labeled, and disposed of by submit an on-line request through the EH&S Assistant Program (https://ehsa.uchicago.edu).

CORROSIVES

HAZARD CLASS DESCRIPTION

A corrosive chemical can cause destruction of living tissue by chemical action at the site of contact. Common classes of corrosives include acids and bases. Corrosives can also damage other substances such as metals. Corrosives are commonly found in research laboratories and used for multiple purposes. Some corrosives require chemical- or process-specific SOPs. Please contact the Office of Research Safety (researchsafety@uchicago.edu) if you have questions.

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some corrosives that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

ADMINISTRATIVE CONTROLS

- Containers should be in good condition and compatible with the material.
- When diluting, add acid or base to water.
- Wash hands thoroughly after handling corrosives.

PPE

- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle corrosives.

- Protective gloves that are appropriate for the chemical being handling must be worn.
- Depending on risk assessment a face shield and/or chemical splash apron may be appropriate.
- Additional PPE may be required if the chemical has additional hazards associated with it.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Store corrosives below eye level.
- Segregate acids from bases.
- Segregate inorganic acids from organic acids.
- Segregate all acids from reactive metals (e.g. sodium potassium, magnesium).
- Segregate all acids from azides and cyanides to prevent adverse reactions.
- Corrosive cabinets should be used in areas where combined volumes of concentrated liquid acids and bases are greater than **10 gallons**.
- Concentrated (>1M) liquid corrosives require secondary containment.
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE
Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL
Decontaminate bench, fume hoods, and other equipment while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult the SDS.
Waste can be collected in a chemically compatible container, labeled, and disposed of by submit an on-line request through the EH&S Assistant Program (https://ehsa.uchicago.edu).

PYROPHORICS

HAZARD CLASS DESCRIPTION
A pyrophoric chemical is a substance that is liable to ignite within 5 minutes after coming into contact with air. As such they must be handled in an inert atmosphere by trained personnel only. All pyrophorics must be stored and handled in buildings that are equipped with emergency sprinkler systems. SDSs should be consulted and followed to ensure appropriate storage for these chemicals. Refrigerators and freezers storing pyrophoric liquids must be designed to store flammable liquids with all electrical equipment that meets Class I, Division I requirements. Pyrophorics require chemical- or process-specific SOPs. Please contact the Office of Research Safety (researchsafety@uchicago.edu) if you have questions.

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits. Never handle pyrophorics in Biosafety Cabinets.
- Some pyrophoric chemicals that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.
- Pyrophoric chemicals may require the use of glove boxes and/ or other air and water free techniques for use and handling.

ADMINISTRATIVE CONTROLS

- A chemical-specific or process SOP should be written for the use of pyrophoric chemicals.
- Laboratory-specific training and documentation of training (hands on) must be completed before the personnel can use pyrophoric chemicals. This may be incorporated into the SOP.
- Containers should be in good condition.
- Inspect any air free seal on containers with highly reactive and unstable chemicals.
- Wash hands thoroughly after handling pyrophoric chemicals.

PPE

- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle pyrophorics.
- Flame-resistant laboratory coats should be worn when working with pyrophorics.
- Protective gloves that are appropriate for the chemical being handling must be worn. The likelihood of fire should also be considered when selecting appropriate gloves.
- Depending on risk assessment a face shield and/or chemical splash apron may be appropriate.
- Additional PPE may be required if the chemical has additional hazards associated with it.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Pyrophorics must be stored and handled under an inert atmosphere.
- Pyrophoric gases must be stored in an appropriate gas cabinet.
- Refrigerators and freezers storing pyrophorics must be designed to store flammable liquids with all electrical equipment that meets the requirements for Class I, Division I Electrical Safety Code (NPFA 45 and 70).
- Never return unused quantities back to the original container.
- Segregate pyrophorics in a secondary container away from incompatibles.
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

In case of a detonation, fire, or other accident, call UChicago Police at **123 (from a campus phone) or 773.702.8181**. Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and other equipment while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult the SDS.

Waste can be collected in a chemically compatible container, labeled, and disposed of by submit an on-line request through the EH&S Assistant Program (https://ehsa.uchicago.edu).

WATER REACTIVE CHEMICALS

HAZARD CLASS DESCRIPTION

A water reactive chemical is a substance that will react with water to produce a toxic or flammable gas. These chemicals must be kept away from water and aqueous solutions. Also avoid storing near or underneath sinks,

safety showers, or emergency eye wash stations. Some water reactive chemicals require chemical- or process-specific SOPs. Please contact the Office of Research Safety (researchsafety@uchicago.edu) if you have questions.

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits. Never manipulate water reactive chemicals in Biosafety Cabinets.
- Some water reactive chemicals that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.
- Water reactive chemicals may require the use of glove boxes and/ or other air and water free techniques for use and handling.

ADMINISTRATIVE CONTROLS

- Containers should be in good condition and compatible with the material.
- Inspect any air free seal on containers with highly reactive and unstable chemicals.
- Chemical-specific or process SOP may be required along with laboratory-specific training.

PPE

- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle water reactive chemicals.
- Protective gloves that are appropriate for the chemical being handling must be worn.
- Depending on risk assessment a face shield and/or chemical splash apron may be appropriate.
- Additional PPE may be required if the chemical has additional hazards associated with it.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Water reactive chemicals must be stored away from water, aqueous solutions, alcohols, sinks, and showers.
- Never return unused quantities back to the original container.
- Store water reactive chemical containers inside appropriate secondary containers.
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

In case of a detonation, fire, or other accident, call UChicago Police at **123 or 773.702.8181**. Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and other equipment while wearing proper PPE. Consult the SDS. Waste can be collected in a chemically compatible container, labeled, and disposed of by submit an on-line request through the EH&S Assistant Program (https://ehsa.uchicago.edu).

PEROXIDE FORMING CHEMICALS

HAZARD CLASS DESCRIPTION

A peroxide forming chemical (PFC) is a substance that may form potentially explosive organic peroxides. Many of these chemicals are common solvents and care must be taken for solutions containing PFCs. A common practice is the addition of stabilizers (e.g. hydroquinone and BHT) that inhibit the chain reaction of peroxide formation. Some peroxide forming chemicals require chemical- or process-specific SOPs. Please contact the Office of Research Safety (researchsafety@uchicago.edu) if you have questions.

There are three classes of PFCs which have different storage requirements. All peroxide forming chemicals must be disposed within 12 months from the open date or before a stamped expiration date whichever is sooner. Any uninhibited peroxide forming chemical must be disposed or used within 3 months of opening. All Class 1 PFCs must be disposed within 3 months from opening. Inhibited Class 2 and 3 PFC must be disposed or used within 12 months of opening.

Class 1 PFCs

Class 1 chemicals form peroxides after prolonged storage. These must be disposed or used within 3 months of opening.

Class 1 PFCs		
Isopropyl ether	Potassium amide	Vinylidene chloride
Divinyl acetylene	Potassium metal	
Divinyl ether	Sodium amide	

Class 2 PFCs

This group of chemicals will readily form peroxides when they become concentrated (e.g., via evaporation or distillation). The concentration process defeats the action of most auto-oxidation inhibitors. As a result, these chemicals should be disposed of within 12 months of opening for bottles with an inhibitor, and 3 months if uninhibited.

Class 2 PFCs		
Acetaldehyde	Diethyl ether	4-Methyl-2-pentanone
Cumene	1,4-Dioxane	Tetrahydrofuran
Cyclohexene	Dimethoxymethane (glyme)	Tetrahydronaphthalene
Cyclopentene	Furan	Vinyl ethers
Diacetylene	Propyne	
Dicyclopentadiene	Methyl cyclopentane	

Class 3 PFCs

This group of chemicals form peroxides that can initiation polymerization. When stored in a liquid state, the peroxide forming potential dramatically increases. These chemicals should be disposed of or used within 12 months of opening for bottles with an inhibitor, and 3 months if uninhibited.

Class 3 PFCs		
Acrylic acid	Chlorotrifluoroethylene	Vinyl acetate
Acrylonitrile	Methyl methacrylate	Vinylacetylene
Butadiene	Styrene	2-Vinylpyridine

Chlorobutadiene	Tetrafluoroethylene	
Vinyl chloride (chloroethene)	1,1-Dichloroethene	

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some peroxide forming chemicals that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

ADMINISTRATIVE CONTROLS

- Containers should be in good condition and compatible with the material.
- Inspect any air free seal on containers with highly reactive and unstable chemicals.
- All peroxide forming chemicals should be marked with the receiving and opening date.
- All peroxide forming chemicals must be disposed of within 18 months of receiving or before any stamped expiration date whichever is sooner.
- All uninhibited peroxide forming chemicals must be disposed of or used within 3 months of opening.
- Class 1 peroxide forming chemicals should be disposed or used within 3 months of opening.
- Class 2, and Class 3 peroxide forming chemicals must be disposed or used within 12 months from opening.
- Wash hands thoroughly after handling peroxide forming chemicals.

PPE

- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle peroxide forming chemicals.
- Protective gloves that are appropriate for the chemical being handling must be worn.
- Depending on risk assessment a face shield and/or chemical splash apron may be appropriate.
- Additional PPE may be required if the chemical has additional hazards associated with it.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Peroxide forming chemicals should be stored in airtight containers in a dark, cool, and dry place.
- The containers should be labeled with the date received and the date opened. This information, along with the chemical identity should face forward to minimize container handling.
- Avoid evaporation or distillation, as distillation defeats the stabilizer added to the solvents.
- Ensure that containers are tightly sealed to avoid evaporation and that they are free of exterior contamination or crystallization.
- Never return unused quantities back to the original container and clean all spills immediately.
- Minimize the quantity of peroxide forming chemicals stored in the laboratory and dispose of peroxide forming chemicals before peroxide formation.
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than two years past the expiration date or if the date of the container is unknown), do not handle the container. If crystallization is present in or on the exterior of a container, do not handle the container. Secure it and contact UChicago Police at **123 (from a campus phone) or 773.702.8181**. Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and other equipment while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult the SDS.

Waste can be collected in a chemically compatible container, labeled, and disposed of by submit an on-line request through the EH&S Assistant Program (https://ehsa.uchicago.edu).

COMPRESSED GAS

HAZARD CLASS DESCRIPTION

Compressed gas cylinders can pose both physical and health hazards. Gas cylinders are pressurized vessels that pose a physical hazard if the pressure is released suddenly and violently. Many compressed gases also posed the health hazard of asphyxiation. Compressed gases can also present moderate (ammonia) to severe (fluorine gas) health and chemical reactivity hazards.

Numerous gases are required for different reasons in the chemical research laboratory. Some gases have additional hazards such as flammability, toxicity, and/or pyrophoricity. Some compressed gases require chemical- or process-specific SOPs. Please contact the Office of Research Safety (researchsafety@uchicago.edu) if you have questions.

ENGINEERING/VENTILATION CONTROLS

- Use and store in a well-ventilated area.
- At a minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some compressed gases that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood or a gas cabinet.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.
- In some cases, oxygen monitors may be required to prevent the risk of asphyxiation.

ADMINISTRATIVE CONTROLS

- Properly secure all gas cylinders.
- Ensure that gas cylinders and regulators are in good condition.
- Always use an appropriate regulator that is compatible with the gas being used.
- Frequently check for leaks using a dilute detergent such as Snoop.
- Gas lines should also be compatible with the gas being used.
- Flammable and oxidizing gases must be stored at least 20 feet apart.

PPE

- At a minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.

- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle compressed gases.
- The area of skin between the shoe and ankle should not be exposed.
- Protective gloves that are appropriate for the chemical being handling must be worn.
- Additional PPE may be required if the chemical has additional hazards associated with it.

HANDLING AND STORAGE

- Do not subject cylinders to temperature extremes.
- Compressed gas cylinders must be stored with the safety cap when not in use.
- Gas cylinders must be secured with a chain or cart.
- Separate storage of flammable and oxidizing cylinders by at least 20 feet or with a fire-resistant barrier at least five feet high and having a fire rating of at least one hour.
- Do not secure more than four cylinders in any one row.
- Store gas cylinders in a vertical position.
- Only transport gas cylinders safely secured on a suitable hand truck.
- Only transport with safety cap on.
- Use a freight elevator when available.
- Mark used cylinders as "Empty".
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Due to the nature of a gas leak or accidental release attempt to close the gas valve if possible, otherwise evacuate and call UChicago Police at **123 (from a campus phone) or 773.702.8181**. Please see for Chapter VII: Emergency Procedures for additional information.

WASTE DISPOSAL

To dispose of compressed gas cylinders used within a laboratory for research, contact the Gordon Center for Integrative Sciences Dock at 773.702.7353 and request a pick-up. All other departments are required to have their contractors dispose of their compressed gas cylinders properly.

CRYOGENIC LIQUIDS

HAZARD CLASS DESCRIPTION

Cryogenic liquids can pose both physical and health hazards. Cryogenic liquids can cause frostbite and these liquids often have large volume expansion factors when they boil. As such cryogenic liquids also pose the health hazard of asphyxiation. Cryogenic liquids are typically stored in tanks also called Dewars. Common cryogenic liquids found in laboratories include liquid nitrogen and helium.

ENGINEERING/VENTILATION CONTROLS

- Use and store in a well-ventilated area.
- At a minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.
- In some cases, oxygen monitors may be required to prevent the risk of asphyxiation.

ADMINISTRATIVE CONTROLS

- Ensure that Dewar flasks and regulators are in good condition.
- Always use an appropriate regulator that is compatible with the gas being used.
- Always use an appropriate pipe for connecting with or dispensing into a Dewar.
- Confirm that the cryogenic tank's safety relief valves have not been modified.
- Under normal conditions, these containers will periodically vent product. Do not plug, remove, or tamper with any pressure relief device.

PPE

- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle cryogenic liquids.
- The area of skin between the shoe and ankle should not be exposed**.**
- Cryogenic gloves should be worn when handling cryogens.
- Based on risk assessment a face shield may be appropriate when handling cryogenic liquids.
- Additional PPE may be required if the chemical has additional hazards associated with it.

HANDLING AND STORAGE

- Never allow any unprotected part of the body to come in contact with un-insulated pipes or equipment that contains cryogenic product.
- Do not store cryogenic liquid containers in a horizontal position.
- Do not store in a confined space.
- Only transport cryogenic liquids secured and with suitable hand truck.
- Do not drop, tip, or roll containers on their sides.
- Use a freight elevator when available.
- Only transfer cryogenic liquids into an appropriate container.
- Special care to ensure that Dewar flasks are in good condition and are shielded or wrapped to contain fragments should implosion occur.
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Due to the nature of a gas leak or accidental release attempt to close the gas valve if possible, otherwise evacuate and call UChicago Police at **123 (from a campus phone) or 773.702.8181**. Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL

To dispose of cryogenic tank used within a laboratory for research, contact the Gordon Center for Integrative Sciences Dock at 773.702.7353 and request a pick-up. Any non-research laboratory departments are required to have their contractors dispose of their cryogenic tanks properly.

PARTICULARLY HAZARDOUS SUBSTANCES

HAZARD CLASS DESCRIPTION

Substances that pose such significant threats to human health are classified as "particularly hazardous substances" (PHSs). The OSHA Laboratory Standard (29 CFR 1910.1450) require that special provisions be

established to prevent the harmful exposure of researchers to PHSs, including the establishment of designated areas for their use. Common examples include sodium azide, toluene, chloroform, dichloromethane, formaldehyde, and ethidium bromide.

Particularly hazardous substances fall under one of three categories.

1. **Acute toxicant**
2. **Reproductive toxicant**
3. **Carcinogen**

Acute toxicants are defined as: Substances that have a high degree of acute toxicity are interpreted by OSHA as being substances that "may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration." These chemicals associated chemical waste, and storage containers must be handled with care to prevent cross contamination of work areas and unexpected contact. These chemicals will have LD_{50}s that are at or lower than:

1. Oral $LD_{50} \leq 50$mg/kg in albino rats
2. Dermal $LD_{50} \leq 200$mg/kg in albino rabbits
3. Inhalation $LD_{50} \leq 200$ppm or 2mg/L for a 1-hour exposure in albino rats

These chemicals must be labeled as "Toxic." Examples include cyanide salts, hydrofluoric acid, and sodium azide.

Reproductive toxicants are defined as: Any chemical that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Reproductive toxins can affect the reproductive health of both men and women if proper procedures and controls are not used. For women, exposure to reproductive toxins during pregnancy can cause adverse effects on the fetus; these effects include embryo lethality (death of the fertilized egg, embryo or fetus), malformations (teratogenic effects), and postnatal functional defects. For men, exposure can lead to sterility.

Examples of embryo toxins include thalidomide and certain antibiotics such as tetracycline. Women of childbearing potential should note that embryo toxins have the greatest impact during the first trimester of pregnancy. Because a woman often does not know that she is pregnant during this period of high susceptibility, special caution is advised when working with all chemicals, especially those rapidly absorbed through the skin (e.g., formamide, DMSO). Pregnant women and women intending to become pregnant should consult with their PI, laboratory supervisor, EH&S, Office of Chemical Safety, their personal physician and/or the University of Chicago Occupational Medicine (if an employee) before working with substances that are suspected to be reproductive toxins.

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

1. Select Carcinogens;
2. Regulated Carcinogens.

Select Carcinogens are materials which have met certain criteria established by the National Toxicology Program or the International Agency for Research on Cancer regarding the risk of cancer via certain exposure routes. (See definition Select Carcinogen.) It is important to recognize that some substances involved in

research laboratories are new compounds and have not been subjected to testing for carcinogenicity. The following references (links provided) are used to determine which substances are select carcinogens by OSHA's classification:

- OSHA Carcinogen List (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10007&p_table=standards)
- Annual Report on Carcinogens (http://ntp.niehs.nih.gov/pubhealth/roc/roc13/index.html) published by the National Toxicology Program (NTP), including all of the substances listed as "known to be carcinogens" and some substances listed as "reasonably anticipated to be carcinogens"
- International Agency for Research on Cancer (IARC, http://monographs.iarc.fr/ENG/Monographs/PDFs/index.php) including all of Group 1 "carcinogen to humans" by the International Agency for Research on Cancer Monographs (IARC) (Volumes 1-48 and Supplements 1-8); and some in Group 2A or 2B, "reasonably anticipated to be carcinogens" by the National Toxicology Program (NTP, http://www.niehs.nih.gov/research/atniehs/dntp/assoc/roc/), and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: (i) 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; (ii) after repeated skin application of less than 300 mg/kg of body weight per week; or (iii) after oral dosages of less than 50 mg/kg of body weight per day

Regulated Carcinogens fall into a higher hazard class and have extensive additional requirements associated with them. The regulations associated with these carcinogens can be found in 29CFR 1910 Subpart Z (https://www.osha.gov/SLTC/carcinogens/standards.html). The use of these agents may require personal exposure sampling based on usage. When working with Regulated Carcinogens, it is particularly important to review and effectively apply engineering and administrative safety controls as the regulatory requirements for laboratories that may exceed long term (8 hour) or short term (15 minutes) threshold values for these chemicals are very extensive.

ENGINEERING/VENTILATION CONTROLS

- At minimum, a chemical fume hood or other containment device is required.

ADMINISTRATIVE CONTROLS

- Containers should be in good condition and compatible with the material.
- Work of PHS should be conducted in a Designated Area.
- Wash hands thoroughly after handling Particularly Hazardous Substances.
- Chemical- or process-specific SOPs may be required. Please contact the Office of Research Safety (researchsafety@uchicago.edu) if you have questions.

PPE

- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle particularly hazardous chemicals.
- Protective gloves that are appropriate for the chemical being handling must be worn.
- Depending on risk assessment a face shield and/or chemical splash apron may be appropriate.
- Additional PPE may be required if the chemical has additional hazards associated with it. This includes respirators which require training and fit testing through EHS.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Store Particularly Hazardous Substances in secondary containers.
- Store and use in Designated Areas only.
- Decontaminate Designated Areas immediately after using Particularly Hazardous Substances.
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and other equipment while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult the SDS.

Waste can be collected in a chemically compatible container, labeled, and disposed of by submit an on-line request through the EH&S Assistant Program (https://ehsa.uchicago.edu).

TOXIC CHEMICALS

HAZARD CLASS DESCRIPTION

Toxic chemicals can refer to chemicals with acute toxicity or chromic toxicity. In addition, toxicity may target a specific organ. This SOP is only for toxic chemicals with an acute toxicity LD_{50} greater than those outlined in the Particularly Hazardous Substance SOP above. Also covered in this SOP are hepatotoxins, nephrotoxins, neurotoxins, and hematotoxins.

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some toxic chemicals that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

ADMINISTRATIVE CONTROLS

- Wash hands thoroughly after handling toxic chemicals.

PPE

- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle toxic chemicals.
- Protective gloves that are appropriate for the chemical being handling must be worn
- Additional PPE may be required if the chemical has additional hazards associated with it

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE
Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL
Decontaminate bench, fume hoods, and other equipment while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult the SDS.
Waste can be collected in a chemically compatible container, labeled, and disposed of by submit an on-line request through the EH&S Assistant Program (https://ehsa.uchicago.edu).

SENSITIZERS AND IRRITANTS

HAZARD CLASS DESCRIPTION
A sensitizer (allergen) is a chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical. An irritant is a chemical other than a corrosive that can cause a reversible inflammatory effect on living tissue by chemical action at the site of contact.

ENGINEERING/VENTILATION CONTROLS
- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some sensitizers and irritants that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded then a chemical fume hood or other engineering controls will be required.

ADMINISTRATIVE CONTROLS
- Handling processes should minimize the potential for incidental contact.
- Once chemical hypersensitivity is detected any contact with the chemical should be avoided
- Wash hands thoroughly after handling sensitizers and irritants.

PPE
- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle sensitizers and irritants.
- Protective gloves that are appropriate for the chemical being handling must be worn.
- Additional PPE may be required if the chemical has additional hazards associated with it. This includes respirators which require training and fit testing through EHS.

HANDLING AND STORAGE
- Keep containers closed when not in use.
- Consult the SDS for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE
Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and other equipment while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult the SDS.
Waste can be collected in a chemically compatible container, labeled, and disposed of by submit an on-line request through the EH&S Assistant Program (https://ehsa.uchicago.edu).

EXPERIMENTAL CHEMICALS/ DRUGS

HAZARD CLASS DESCRIPTION

Laboratories at the University of Chicago may be using chemicals for pharmaceutical or other types of research synthesized by the laboratory, a collaborator, or a pharmaceutical company. Included in this hazard class are nanomaterials. Chemicals from collaborators from outside the University of Chicago should provide a Safety Data Sheet for the chemical; however, some of these chemicals or drugs are not very well characterized and have limited physical, chemical, or toxicological information. These chemicals are therefore considered experimental and must be handled as if they are highly hazardous. A SOP regarding their use and disposal is recommended.

ENGINEERING/VENTILATION CONTROLS

- Experimental chemicals/drugs could be carcinogenic, an acute toxicant, and/or a reproductive toxicant, so the use of a chemical fume hood or other engineering control is required.

ADMINISTRATIVE CONTROLS

- Handling processes should minimize the potential for incidental contact.
- Wash hands thoroughly after handling experimental chemicals or drugs.

PPE

- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle experimental chemicals.
- Protective gloves that are appropriate for the chemical being handling must be worn.
- Additional PPE may be required if the chemical has additional hazards associated with it. This includes respirators which require training and fit testing through EHS.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Store in a secondary container.
- Consult the SDS (if available) for chemical-specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and other equipment while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult the SDS.
Waste can be collected in a chemically compatible container, labeled, and disposed of by submit an on-line request through the EH&S Assistant Program (https://ehsa.uchicago.edu).

HIGH TEMPERATURE

HAZARD CLASS DESCRIPTION

High temperature reactions can cause burns from touching hot equipment or from fire. Laboratories will often use heating plates, sand baths, oil baths, heating mantels, ovens, and occasionally open flame to achieve high temperatures.

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to maintain exposure to any heated or volatilized substances below any regulatory limits.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.
- When using carcinogens, acute toxicants, and reproductive toxicants in high temperature experiments the use of a chemical fume hood or other engineering control is required.
- Thermocouples can be used to shut off heat in case of thermal runaway.

ADMINISTRATIVE CONTROLS

- Do not touch items while they are hot.
- Often, hot and cold items look the same, so assume that heating equipment is hot.
- Unplug all heat guns when not in use.
- Job safety analysis or SOPs may be appropriate for some high temperature experiments. Please contact the Office of Chemical Safety or EHS with any questions.

PPE

- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required.
- Flame resistant laboratory coats should be worn if an open flame is in use**.**
- Protective gloves that are appropriate for the hazard must be worn.
- Additional PPE may be required if the chemical has additional hazards associated with it.

HANDLING AND STORAGE

- Use and store in a well-ventilated area.
- When heating chemicals be sure to check the materials flash point and smoke point.
- Allow equipment to cool completely before storing.

SPILL AND ACCIDENT PROCEDURE

In case of a detonation, fire, or other accident, call UChicago Police at **123 (from a campus phone) or 773.702.8181**. Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Follow the proper decontamination and waste procedure for the chemical use in the high temperature experiment.

HIGH PRESSURE

HAZARD CLASS DESCRIPTION

High pressure reactions require special pressure vessels and may require additional controls to avoid rapid swings in pressure that could spontaneously depressurize resulting in serious injuries and/or property damage. Main hazards include impact from an explosion, exposure to hazardous chemicals from uncontrolled release, or fire.

ENGINEERING/VENTILATION CONTROLS

- Use and store in a well-ventilated area.
- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.
- Some chemicals used in high pressure systems which are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- Based on risk assessment a weighted blast shield may be appropriate when handling high pressure vessels.
- Flash-back arrestors should be used when flammable gases are used.

ADMINISTRATIVE CONTROLS

- Follow all manufacturer instructions when using a pressure vessel.
- Never exceed the recommended pressure for a given container.
- Temperature control may be required to control reaction rates and pressure
- Be aware of possible decomposition products and their effects on the pressure.
- Check seals and other components for corrosion or wear before and after every experiment and replace if necessary.
- Warn others in the lab of the hazard when high pressure equipment is in use.
- Job Safety Analysis or SOP with emergency shutdown procedures should be developed.

PPE

- At minimum, long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle equipment at high pressure.
- The area of skin between the shoe and ankle should not be exposed**.**
- Protective gloves that are appropriate for the chemical being handling must be worn.
- Based on risk assessment a face shield may be appropriate when handling high pressure vessels.
- Additional PPE may be required if the chemical has additional hazards associated with it.

HANDLING AND STORAGE

- During the experiment, monitor for leakage, pressure relief valve discharges, and any sudden changes in temperature or pressure.
- After the experiment, check the vessel over and replace any worn or corroded parts.
- Follow the manufacturer's recommendation regarding decontamination and storage.

SPILL AND ACCIDENT PROCEDURE

In case of a detonation, fire, or other accident, call UChicago Police at **123 (from a campus phone) or 773.702.8181**. Please see for Chapter VII: Emergency Procedures for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Follow the proper decontamination and waste procedure for the chemical use in the high-pressure experiment.

ELECTRICAL SAFETY IN THE LAB

HAZARD CLASS DESCRIPTION

Electrical safety inside a lab is very important as general practice and because some laboratory equipment requires high voltage and power. Such equipment includes lasers and electrophoresis power supplies.

ADMINISTRATIVE CONTROLS

- Power strips must be kept off the ground and away from sinks, chemicals, or other splash hazard.
- Do not overload circuits.
- Do not use extension cords for permanent wiring.
- Do not use any damaged electrical equipment including worn or frayed wiring.
- Do not block electrical panels.
- Do not pull on the cords.
- Properly ground all required equipment.
- Only University of Chicago approved electricians should modify any wiring or circuits.

SPILL AND ACCIDENT PROCEDURE

In case of fire or injury, call UChicago Police at **123 (from a campus phone) or 773.702.8181**. Please see for Chapter VII: Emergency Procedures for additional information.

Appendix A: Laboratory-Specific Training Requirements and Documentation

All laboratories are required to complete laboratory-specific training and to maintain the documentations. This section of the Chemical Hygiene Plan is here to assist researchers in organizing and documenting laboratory specific training. At minimum all researchers must complete a laboratory-specific orientation. An ORS suggested Research Personnel Orientation Checklist can be found in the References and Resources section of our website. A suggested training record log sheet can also be found on our website. For any questions regarding the requirements for laboratory-specific training or recommended trainings to be completed please contact Office of Research Safety (researchsafety@uchicago.edu).

Appendix B: Laboratory-Specific Standard Operating Procedures

Laboratories are required to complete Standard Operating Procedures for chemicals or processes that are not sufficiently covered by this Chemical Hygiene Plan Template. The completion and documentation of laboratory standard operating procedures is part of the requirement to make this template into a laboratory-specific Chemical Hygiene Plan. Laboratories can find Standard Operating Procedure Templates on our website. Laboratories are also encouraged to contact Office of Research Safety (researchsafety@uchicago.edu) if they have questions or concerns regarding standard operating procedures.

Appendix C: Laboratory-Specific Emergency Procedures

Laboratories are encouraged to develop their own specific emergency procedures. Special shut down instructions or other emergency procedures should be documented and organized in this section. Please contact the University of Chicago Emergency Management, Environmental Health and Safety (773.70**2.9999**), or Office of Research Safety (773.83**4.2707**) if you have questions.