Research
Research Laboratory & Safety Services

University of Arizona
Chemical Hygiene Plan

Research Laboratory & Safety Services
Jan 2021

Research Laboratory & Safety Services (RLSS) is the primary coordinating unit responsible for the Laboratory Chemical Safety Program (LCSP) at the University of Arizona. The University Chemical Hygiene Plan (UCHP) is maintained at RLSS at 1717 E Speedway Blvd, Suite 1201, Tucson, AZ, and is readily available to anyone via the RLSS website (rgw.arizona.edu/compliance/RLSS). It will be reviewed, evaluated, and updated at least annually by RLSS.

This document replaces all previous versions of the University Chemical Hygiene Plan, and as a regulatory compliance document represents University governance of the information included herein.

Summary of Changes

Disability & Accommodation Statement	Date
Updated Hazard Communication Plan	1/5/2020
Clarification of Roles & Responsibilities	1/5/2020
Reorganization of Sections	1/5/2020
Updated inspection, hazardous chemical disposal, and response information, shutdown of dangerous activities	1/5/2020
Updated USOPs (hazardous gas, new controlled substances and cryogenics SOPs)	1/5/2020

Contents

1 Introduction

The University of Arizona (UArizona) Research Laboratory & Safety Services (RLSS) is committed to helping Principal Investigators (PIs), other faculty, staff and students create and sustain a safe laboratory environment that is free from all recognizable hazards for researchers to work and discover. RLSS aims to promulgate a culture of safety to ensure the health and safety of all laboratory workers from both the top down and bottom up and which includes "habitual risk assessment, experiment planning, and consideration of worst-case possibilities—for oneself and one's fellow workers." (National Research Council, Prudent Practices in the Laboratory, 2011)

PIs and academic faculty instructing in a laboratory setting are either considered "employers" or "supervisory agents" and are delegated the local authority, control and responsibility to complete their research/instruction in compliance with applicable regulatory requirements Every PI/instructor with responsibility over a hazardous chemical use laboratory, or set of laboratories, must register with RLSS into UArizona Laboratory Chemical Safety Program (LCSP). While most PIs will register as their own Approval Holder (AH) in the LCSP, and take on the responsibilities as such, some PIs may work under a different AH, not having an approval of their own.

1.1 Purpose

This Chemical Hygiene Plan (CHP) satisfies the requirements of the Occupational Safety and Health Administration (OSHA) standards 29 CFR 1910.1450 ("Occupational Exposure to Hazardous Chemicals in Laboratories") and 29 CFR 1910.1200 ("Hazard Communication Standard"), respectively.

This plan:

- Defines UArizona Laboratory Chemical Safety Program, which was created to protect laboratory workers from health hazards associated with hazardous chemicals in the laboratory and to keep exposures below the exposure limits specified by OSHA, as well as the National Institute of Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH).
- Describes the proper use and handling practices and procedures to be followed by faculty, staff, students, visiting scholars, volunteers, and all other personnel working with potentially hazardous chemicals in laboratory settings.

This plan is also based on best practices identified in, among other sources, "Prudent Practices for Handling Hazardous Chemicals in Laboratories, published by the National Research Council and the American Chemical Society's "Safety in Academic Chemistry Laboratories."

1.2 Scope

The UCHP shall act as the overarching, general plan for all hazardous chemical use on a laboratory scale at the University of Arizona. All faculty, staff, students, volunteers, visiting scholars and other personnel using hazardous chemicals in a research or teaching laboratory must adhere to the requirements detailed in this document. Off-campus (satellite) locations (i.e. College of Medicine-

Phoenix, Biosphere 2, etc.) may have additional requirements, which will be communicated with building/facility coordinators. The use and storage of hazardous chemicals in a non-laboratory setting falls under the occupational health and safety programs maintained by Risk Management Services (RMS).

The UCHP shall be made readily available to all PIs, laboratory workers, and to the Assistant Secretary of Labor for Occupational Health & Safety, U.S. Department of Labor or designee upon request. **Laboratory workers must know and attest to knowing the location of the UCHP, be familiar with its contents and be able to provide it to any state or federal regulatory inspectors upon request**.

The information presented in the UCHP represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize potentially hazardous chemicals. It is not intended to be all inclusive. Laboratories, research or otherwise, engaged in work with potentially hazardous chemicals that have unusual characteristics, or are otherwise not sufficiently covered in the UCHP, must create their own Laboratory Chemical Hygiene Plan (LCHP) addressing the hazards and how to mitigate their risks, as appropriate. LCHPs must receive prior approval from the PI/AH, ASC, and the University of Arizona's Chemical Hygiene Officer (CHO).

1.3 Rights of a Laboratory Worker

Employees and any other personnel who work in laboratories have the right to be informed about the potential hazards of the chemicals in their work areas and to be properly trained to work safely with these substances. This includes Facilities Management staff and any other personnel (including contractors) who work to clean and maintain laboratories. Employees have the right to file a complaint with the Arizona Department of Occupational Safety & Health (ADOSH) if they feel they are being exposed to unsafe or unhealthy work conditions and cannot be discharged, suspended, or otherwise disciplined by their employer for filing a complaint or exercising these rights. All personnel working with potentially hazardous chemicals are encouraged to report (anonymously, if preferred) any concerns about unsafe work conditions to their AH, ASC, and/or RLSS at 520-626-6850 or RLSS-help@arizona.edu. RLSS also has a Near Miss Reporting tool that can be used to report near miss events or other safety concerns.

These rights are protected by ensuring every laboratory worker has access to this plan, as well as LCHP(s) that provide important information on the hazardous chemicals in a worker's laboratory. Adequate training is provided by the General Laboratory Chemical Safety Training from RLSS and Laboratory-Specific Training provided by their AH or designee. The RLSS User Dashboard's hazardous chemical inventory provides information on the identify, physical and health hazards of chemicals in a specific work area; this includes access to Safety Data Sheets (SDS).

All personnel, including AH/ASCs, employees, and students, have a duty to fulfill their obligations with respect to maintaining a safe work environment. All employees and other personnel working with potentially hazardous chemicals have the responsibility to conscientiously participate in training seminars on general laboratory safety and review and be familiar with the contents of the UCHP and their LCHP. Those working with chemicals are responsible for staying informed about

the chemicals in their work areas, safe work practices and proper personal protective equipment (PPE) required for the safe performance of their job. Failure to comply with these requirements may result in temporary suspension of laboratory activities as per this CHP until corrective action is implemented and verified.

Together, these plans and trainings, as well as the laboratory worker's ability to communicate directly with RLSS help to create a safe work environment.

1.4 Responsibilities

1.4.1 University Leadership and Administrators

All university administrators, including the President, Vice Presidents, Provosts, Deans, Department Heads and Directors, hold the following responsibilities:

- Ensure that individuals under their management in a research or instructional laboratory setting have the authority to implement the UCHP.
- Ensure areas under their management are in compliance with the UCHP.

For most situations, administrators depend on the LCSP to carry out their responsibilities.

1.4.2 Senior Vice President for Research (SVPR)

The SVPR relies on RLSS for the development and maintenance of UArizona LCSP. The SVPR holds the following responsibilities:

- Provide regulatory compliance resources for UArizona research community.
- Support UArizona Laboratory Chemical Safety Program (LCSP).
- Appoint a Chemical Hygiene Officer to maintain and administer the LCSP.
- Upon the discretion of executive management, appoint an interdisciplinary Research Health & Safety Committee (RHSC) of professionals with hazardous chemical experience to oversee the use of hazardous chemicals in all University research settings.

1.4.3 Chemical Hygiene Officer (CHO)

The Chemical Hygiene Officer (CHO) has primary responsibility for implementing the LCSP, including the UCHP. The CHO will function as the chemical safety committee, with assistance from relevant parties, until a one is created. Contact information for the CHO can be found on the RLSS website, or by calling (520) 626-6850. The CHO is responsible for:

- Informing AH/ASCs of all health and safety requirements and assisting with the selection of appropriate safety controls, including laboratory and other workplace practices, personal protective equipment, engineering controls, training, etc.;
- Conducting periodic inspections and taking steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
- Performing hazard assessments, as deemed necessary and upon request;
- Obtaining and utilizing, when necessary, area and personal exposure monitoring records;
- Helping to develop and implement appropriate chemical hygiene policies and practices;

- Having working knowledge of current health and safety rules and regulations, training, reporting requirements and standard operating procedures associated with regulated substances. Such knowledge may be supplemented and developed through research and training materials;
- Working researchers to review existing and develop new SOPs for handling hazardous chemicals;
- Providing technical guidance and investigation, as appropriate, for laboratory and other types of accidents and injuries;
- Reviewing plans for installation of engineering controls and new facility construction/renovation, as requested;
- Reviewing and evaluating the effectiveness of the UCHP at least annually and updating it as appropriate; and
- Providing guidance with environmental compliance, transport and disposal of hazardous waste.

1.4.4 Research Health & Safety Committee (RHSC)

The OSHA *Occupational Exposure to Hazardous Chemicals in Laboratories Standard* recommends the formation of a chemical safety committee for large institutions, including universities. At the discretion of the SVPR, the CHO will form a Research Health & Safety Committee (RHSC) with members who will be appointed by RLSS and be instrumental in the development of a Charter. Through regular meetings, the RHSC will review key aspects of the LCSP and advise executive management, the SVPR, RLSS and AHs when extra precautions should be required, based on their knowledge and professional experience.

1.4.5 Research Laboratory & Safety Services (RLSS)

RLSS is responsible for administering and overseeing the LCSP at UArizona. In order to accomplish this, RLSS works with researcher PI's and faculty to help them achieve and maintain compliance with relevant OSHA regulations. RLSS also holds the following responsibilities:

- Have working knowledge of current health and safety rules/regulations.
- Review and update the UCHP and University Standard Operating Procedures (USOPs) at least annually.
- Maintain the RHSC charter. Before a committee is established and the charter is approved by the SVPR, RLSS will continue to work with specific department heads (Chemistry & Biochemistry, Pharmacology & Toxicology, University Animal Care and Risk Management Services) and other University entities (i.e. Office of General Counsel, UA Occupational Health) on an ad-hoc basis, as advisors.
- Provide General Laboratory Chemical Safety Training to all laboratory workers.
- Provide guidance and technical assistance to hazardous chemical-use laboratory workers to obtain and maintain laboratory compliance with current OSHA, Drug Enforcement Administration (DEA), & the Bureau of Alcohol, Tobacco, Firearms, and Explosives (BATFE) regulations.
- Maintain a comprehensive online dashboard for every hazardous chemical Approval to facilitate regulatory compliance and provide hazard information. The online User

Dashboard includes the UCHP and an AH's LCHP, the AH's authorizations, chemical inventory, and worker training records for the laboratory.

- Perform hazard assessments and aid in the development of LCHPs and/or Laboratory Standard Operating Procedures (LSOPs).
- Perform scheduled regular inspections of UArizona hazardous chemical-use laboratories, with follow-up as needed.
- Conduct hazard assessments, exposure monitoring, when necessary, to assess laboratory exposures to hazardous chemicals.
- Provide hazard warning signs, labels and other hazard communication requirements for the laboratory work environment.
- Act as a liaison on behalf of hazardous chemical-use laboratories to regulatory agencies, the RHSC, Risk Management Services (RMS), Facilities Management (FM) and any other entity involved in maintaining laboratory chemical safety compliance.
- Eliminate or curtail any activity considered to constitute a significant danger to the health and safety of laboratory workers, environment, or institutional reputation.
- Act as a notification authority in the case of a major chemical event/incident in the laboratory. In the case of an emergency, RLSS will act as a liaison between the Incident Commander and/or Risk Management Services Director or designee, and the laboratory.
- Maintain records of all laboratory chemical safety inspections, exposure monitoring and emergency responses.
- Monitor building/site aggregate chemical inventories for compliance with the Chemical Facility Anti-Terrorism Standards (CFATS).
- Support the University of Arizona Respiratory Protection Program (RPP) and Hearing Conservation Program (HCP).

1.4.6 Risk Management Services (RMS)

Risk Management Services is responsible for the comprehensive health and safety programs for employees working outside of a laboratory environment at UArizona and has the following functions:

- Perform hazard assessments and provide guidance and technical assistance to RLSS regarding health, safety, and environmental problems to UArizona workers outside of the laboratory.
- Support the University of Arizona Respiratory Protection Program (RPP) and Hearing Conservation Program (HCP).
- Provide Fire Safety training for laboratory workers.
- Provide guidance and assistance to RLSS on International Fire Code (IFC) compliance issues in laboratories.
- Provide a safe, efficient mechanism for the removal of hazardous chemical wastes (excluding radioactive materials) from laboratories and arrange for proper management and disposal of those wastes.
- Perform OSHA injury/incident reporting and insurance filings for worker's compensation.
- Coordinate institutional insurance coverage for losses involving UArizona property, general and professional liability, and employee injury.

- Act as the Incident Commander or advisor to the Incident Commander during chemical-related emergencies such as major chemical spills and accidents.
- Serve as a liaison on behalf of the University to regulatory agencies concerning regulatory compliance with occupational safety, health, and environmental concerns.
- Ensure that adequate records are kept of all regulatory agency inspections, assessments, OSHA required programs (RPP, HCP, etc.) emergency responses, and hazardous waste activities.

1.4.7 Principal Investigator (PI)/Approval Holder (AH)

Though the AH may assign an Approval Safety Coordinator (ASC) to perform many, if not all, of the responsibilities listed below, **the PI/AH is ultimately responsible for ensuring that their laboratories are compliant** with the LCSP and all relevant safety regulations. RLSS is available to assist the AH with ensuring a safe and compliant workplace. The AH's responsibilities are to:

- Be an active participant in the LCSP.
- Identify any and all hazardous conditions or operations in the laboratory or other facility containing hazardous chemicals and determining safe procedures and controls and implementing and enforcing standard safety procedures.
- Know all applicable health and safety rules and regulations, training/reporting requirements, and SOPs associated with chemical safety for the substances used in their laboratory.
- Recognize any hazardous conditions or operations within the laboratory and implement safe procedures and controls.
- Work with RLSS to develop, publish and implement a LCHP and relevant Laboratory Standard Operating Procedures (LSOPs), to be reviewed and updated at least annually or as needed.
- Ensure all laboratory workers under their direction successfully complete all required trainings:
  1. General Laboratory Chemical Safety Training provided by RLSS;
  2. Laboratory Specific Training, which should be provided to laboratory workers and visitors;
  3. RMS online "Fire Safety Awareness" (all workers must complete), with option to continue with the "Fighting Fires with Portable Fire Extinguishers" in-person course.
- Ensure appropriate personal protective equipment (PPE) is available to laboratory workers.
- Provide prior approval to laboratory workers for the use of certain hazardous chemicals ("particularly hazardous chemicals") in the laboratory; consult RLSS about the use of particularly hazardous inhalation hazard class chemicals outside of a chemical fume hood.
- Ensure that all hazardous waste is stored and disposed of properly, and that Risk Management Services is notified when waste collection is required.
- Report all incidents and near misses to RLSS; report injuries to both RLSS and RMS and work with physicians in the case of required medical evaluations and/or consultations.
- Maintain an updated chemical inventory for the laboratory, including Safety Data Sheets (SDSs), using the RLSS User Dashboard.
- Maintain adequate records of all training, incidents, medical evaluations, plans, SOP's, inspections and corrective actions taken.

1.4.8 Approval Safety Coordinator (ASC)

An AH may or may not appoint an ASC to carry out select responsibilities and act as a point of contact for RLSS. An ASC is first and foremost a laboratory worker, however, and is therefore also required to carry out all responsibilities in attributed to laboratory workers.

1.4.9 Laboratory Worker

A laboratory worker is anyone in research and/or teaching laboratories that use or store potentially hazardous chemicals are responsible. Teaching assistants in instructional laboratories are also considered laboratory workers due to their oversight responsibilities over our student body.

Laboratory workers hold the following responsibilities:

- Read and follow the requirements of the UCHP and LCHP, as well as any other appropriate policies and/or procedures (i.e. University or Laboratory Standard Operating Procedures).
- Don appropriate Personal Protective Equipment (PPE) and appropriate laboratory/classroom attire as directed by the UCHP/LCHP or instructor/TA/PI (AH).
- Complete the General Laboratory Chemical Safety Training.
- Complete Laboratory Specific Training with their AH or ASC.
- Complete any other health and safety training as required by the UCHP/LCHP (e.g. Respirator Fit Testing, Fire Safety Awareness).
- Plan and conduct each laboratory experiment or operation in accordance with the requirements of the UCHP/USOPs or specified further in the LCHP/LSOP's.
- Understand the capabilities and limitations of PPE provided.
- As per the LCHP, gain prior approval from the AH/ASC for the use of restricted chemicals and other identified materials; consult with the AH/ASC before conducting any perceived high-risk experimental procedures (i.e. unattended reactions, scale-ups, substitutions, heating, combustion, use of toxic compressed gases).
- Develop good personal chemical safety and hygiene habits; this includes keeping the work areas safe, clean and uncluttered.
- Immediately report all incidents, near misses, and unsafe acts/conditions to the AH/ASC. If preferred, anonymous reports can be sent to RLSS at 520-626-6850 or RLSS-help@arizona.edu.
- Participate in the medical surveillance program when required and inform the AH/ASC of any work modifications ordered by a physician as a result of medical surveillance, occupational injury or exposure.

1.4.10 Facilities Management (FM)

Facilities Management holds the following responsibilities:

- Maintain and repair the physical facilities of the laboratory.
- Ensure safety devices installed as permanent improvements or installations of the building by FM, or through Planning, Design & Construction (PDC), are in proper working condition (e.g. fire extinguishers, fire alarm systems, emergency eyewashes and showers, and chemical fume hoods, gas cabinets, local exhausts, etc.).

At some satellite locations, these responsibilities may be contracted with an outside vendor. Contact your facility coordinator/building manager for further information.

1.4.11 Procurement and Contracting Services (PACS)

The Department of Procurement and Contracting Services are responsible for the safe procurement and delivery of all chemicals purchased through them with University funds.

1.4.12 Cryogenics & Compressed Gas Facility

The University Cryogenics & Gas Facility is responsible for the safe procurement and delivery of all compressed gases in cylinders and disposal of cylinder larger than lecture bottle size. Additionally, they are responsible for the delivery of cryogenic materials (e.g. liquid nitrogen). University laboratories at satellite locations (i.e. College of Medicine Phoenix, etc.) may utilize other companies and facilities.

1.4.13 University of Arizona Police Department (UAPD), Tucson Fire Department (TFD) & Emergency Medical Services (EMS)

University Police, the Tucson Fire Department and Emergency Medical Services provide emergency services to laboratory personnel (e.g. medical, fire, major spill response, security). **For life-threatening situations or work-related injuries that cause intense discomfort, call 911.** University laboratories at satellite locations will rely on assistance from the nearest emergency responders (call 911) in the case of a chemical-related emergency.

For non-life-threatening injuries to University **staff**, contact the Triage line at 1-(800) 685-2877. The triage line will report the injury to state insurance (workman's compensation) and UA Risk Management Services Department as well as offer treatment advice.

For non-life-threatening injuries to University **students**, contact Campus Health Services (CHS) at (520) 621-6490.

1.4.14 UA Occupational Health (OH)

OH holds the following responsibilities:

- Provide treatment and referral for work-related injuries and illnesses to university employees and students.
- Oversight of hearing conservation program (HCP), respiratory protection program (RPP) (e.g. medical clearance, respirator fit testing), animal hazards protection program (e.g. animal allergens, allergen treatment), work related injury support, medical surveillance and immunizations programs for designated University employees on/near the main Tucson campus.

University laboratories at satellite locations may receive such medical attention/surveillance from the nearest licensed health care provider.

- The OH Clinic is located in the Babcock Building (#151) suite 1128.

- Contact the clinic by phone (520) 621-5643, OccHealth-Support@email.arizona.edu , or at occhealth@arizona.edu if you have any questions or require service.

1.4.15 Arizona Poison and Drug Information Center (APDIC)

The Arizona Poison and Drug Information Center (APDIC) (1-800-222-1222) provides the following services in support of the Laboratory Chemical Safety Program:

- Poison and medication-related emergency treatment advice,
- Referral assistance and comprehensive information on poisons, toxins, poison prevention and the safe and proper use of medications, and
- Assistance and advice to pregnant females concerning drug and poison control from laboratory and other exposures.

1.4.16 Laboratory Visitors

Every visitor to a laboratory must follow certain general safety procedures. Special rules apply for minors visiting or working in a laboratory; see Section 7.6 for further information. Visitors who are not working with hazardous chemicals (e.g. tour groups) must always be supervised when in the laboratory; such visits typically do not exceed a day in length.
Any visiting researcher or student working in a hazardous chemical-use laboratory for two weeks or less does not need be added to the PI's chemical safety approval, nor do they need to complete the General Laboratory Chemical Safety Training. However, they will need to:

- Complete and document Laboratory Specific Training with the AH or ASC.
- Always be supervised by a trained laboratory worker, designated by a PI/Faculty/AH whenever working or involved with hazardous chemicals in the laboratory.

Visiting researchers or students working in the laboratory for more than two weeks must be added to the PI/Faculty/AH chemical safety approval. They hold the following responsibilities:

- Register with their host UA department as a Designated Campus Colleague (DCC) to receive a UA NetID. The DCC process can be lengthy (depending on the department), and visitors should begin the process before working in the laboratory.
- Complete the General Laboratory Chemical Safety Training.
- Complete Laboratory-Specific training provided by the AH or ASC.

Once both required trainings are completed, the visitor may work in the laboratory.

1.4.17 Disability and Accommodations

It is the policy of the University of Arizona to comply fully with the requirements of the Americans with Disabilities Act of 1990 as amended by the Americans with Disabilities Act Amendments Act of 2008 and all other federal and state laws and regulations prohibiting discrimination and assuring accessibility on the basis of disability. Please contact RLSS and the Disability Resource Center (DRC) if there are concerns about equity, accommodations, or guidance for working in the laboratory with a disability.

1.5 Basic Safe Laboratory Practices

- Do not work alone in the laboratory if the procedures conducted involve highly hazardous substances or processes; use the buddy system by staying on a Zoom call, checking in via text, or other system. It is extremely important to understand the risks of working alone.
- Prevent Chemical exposures by:
    - Using the appropriate personal protective equipment (PPE), including gloves, lab coats, eyewear, and long pants/sleeves.
    - Clean up spills as soon as possible and minimize clutter at workspaces to avoid inadvertent exposure.
    - Do NOT inhale or taste chemicals: use a fume hood or engineering control, cap as soon as done using, never use a mouth pipette, and waft only if absolutely necessary.
- Practice good personal hygiene: wash hands well with soap and warm water after removing gloves AND before leaving the laboratory area. You should never wash your hands with organic solvents.
- Food and drink consumption in the laboratory increase the chance of exposure to chemicals; they are prohibited from being stored, prepared, or consumed in the laboratory.
- Keep access to exits and emergency equipment clear at all times.
- Follow laboratory signage and postings; refresh signage as needed.
- Keep lab bench tops, sinks, floors, other work surfaces clear of clutter and clean.
- Segregate and store chemical properly; flammables in the flammable cabinet, only compatible chemicals near one another.

2. Hazard Communication

The UArizona Laboratory Hazard Communication Plan (required by OSHA 29 CFR 1910.1200) is incorporated within this CHP. It is designed to provide information to their employees about the hazardous chemicals to which they are exposed by means of a hazard communication program, labels, and other forms of warning, safety data sheets, and information and training. RLSS assists researchers in providing training and in selecting appropriate engineering controls, work practice controls, and Personal Protective Equipment (PPE) to comply with this standard.

The purpose of the Laboratory Hazard Communication Program is to ensure that:

- Hazardous chemicals present are properly labeled and identified,
- Employees and students have access to information on all known hazards of these substances,
- Employees and students receive proper training on how to prevent adverse effects due to exposure to these

This information is provided by a laboratory worker's AH and/or ASC, as well as RLSS, as governed by the requirements of this section.

2.1 Hazard Determination

2.1.1 Chemicals from a Manufacturer

Laboratories rely on the hazard information provided by manufacturers and distributors to determine the hazards of most chemicals. This information is commonly found in the form of a hazardous chemical label or Safety Data Sheet (SDS), formally known as Material Safety Data Sheets (MSDSs). Additional information on the hazards presented by a chemical can be found in the literature or by contacting the Arizona Poison and Drug Information Center (APDIC) at 1-800-222-1222. The APDIC is also available for emergency information on drug, chemical, plant or insect poisonings/exposures.

2.1.2 Newly Synthesized (Novel) Chemicals

If a laboratory creates a novel chemical, the AH of the laboratory is responsible for ensuring that containers of newly synthesized chemical(s) are properly labeled. These labels must include the chemical name and any known hazard information on the label. If the hazards of a novel chemical are unknown (which will often be the case), the label should indicate that the potential hazards of the substance have not been tested and are unknown. If a novel chemical is being provided to another researcher or transferred outside of UArizona for testing/analysis, the AH must also create a SDS for the chemical that includes all known chemical and physical properties, hazards and regulatory information for the chemical. An SDS template is available on the RLSS website, as well as labeling guides for mixtures and novel chemicals.

2.1.3 Mixtures of Hazardous Chemicals

If a mixture of hazardous chemicals is not from a manufacturer or distributor, and the mixture itself has not been tested for potential hazards, laboratory workers should use appropriate controls for the combination of the hazards presented by each chemical component of the mixture. Contact RLSS to assist with classifying the hazards of mixtures for generation of container labels and SDSs. Workers should assume, in the absence of data, that the mixture will be more toxic than the most toxic component in the mixture.

2.2 Chemical Hazard Categories

UArizona Laboratory Chemical Safety Program follows the OSHA categorization of chemicals as non-hazardous, hazardous, and particularly hazardous. Compounds that are federally regulated, but do not fall under these hazard categories (i.e. controlled substances and explosive materials) are explained in further detailed in this plan, section "*Chemicals and Procedures Requiring Prior Approval"*.

2.2.1 Non-Hazardous Chemicals & Consumer Products

Chemicals that do not present either a physical or health hazard are considered non-hazardous. These chemicals do not have to be entered into the approval's User Dashboard hazardous chemical inventory interface; however, it is still highly recommended as a best practice. All non-hazardous

chemical containers must still be labeled with the chemical's full name to ensure it is not mistaken for a hazardous compound.

Consumer products used in research may pose hazards to their users. These products do not have to be entered into the User Dashboard hazardous chemical inventory if used in accordance with the manufacturer's intent; RLSS still recommends it be entered as a best practice. If the commercial product is being used in quantities and frequencies greater than a normal consumer, they fall under the purview of the hazard communication plan (need to be added to the online User Dashboard hazardous chemical inventory). All consumer products must be labeled with the product's full name when outside the commercial container to ensure it is not mistaken for a non-hazardous compound. This includes the use of disinfectant solutions (EPA-approved), which must be labeled with the appropriate EPA label.

2.2.2 Hazardous Chemicals

A hazardous chemical has significant evidence of presenting a physical and/or health hazard. While potentially dangerous, these chemicals are of lower risk than those categorized as particularly hazardous chemicals. All hazardous chemicals used/stored in the laboratory must be inventoried within the approval's RLSS online User Dashboard inventory and SDS interface.

2.2.3 Particularly Hazardous Chemicals

Particularly hazardous chemicals present higher risks than hazardous chemicals and are defined by OSHA regulations to include "select carcinogens, reproductive toxins and substances which have a high degree of acute toxicity." The RLSS online User Dashboard inventory and SDS interface identifies particularly hazardous chemicals within a chemical inventory. The use of particularly hazardous chemicals shall be given specific consideration by the AH in the development of the LCHP. In addition to a more detailed LCHP, AHs using or storing particularly hazardous chemicals will undergo more stringent hazard assessment and LCHP approval process.

2.3 Hazard Classification System

UArizona has adopted the Globally Harmonized System (GHS) for the classification of hazardous chemicals, as per the OSHA Hazard Communication Standard (29 CFR 1910.1200). Manufacturers classify their chemicals according to GHS "hazard statements," which explain the type of hazards presented by each chemical. GHS also assigns a set of standard control measures to address each hazard statement, known as "precautionary statements."

RLSS has grouped the 33 specific GHS hazard classes into 11 generalized hazard classes. **The hazard class(es) of a chemical will determine how it should be stored, handled and disposed**. **The following pages provide a brief description of each classes, the associated hazard information that can be found in the SDS, and the** category of the hazard. It is essential that all laboratory workers understand this hazard classification system and can recognize their potential routes of exposure. The hazard class and category (non-hazardous, hazardous, or particularly hazardous) of each chemical are available to laboratories through the online User Dashboard hazardous chemical inventory. A University Standard Operating Procedure (USOP) has been

created for each of the 11 hazard classes, and these USOPs cover the hazards presented by each class, as well as required control measures and emergency procedures. **These USOPs are not all encompassing, and all available literature AND RLSS should be used to assess the potential hazards and most appropriate methods of control**.

2.3.1 Compressed Gases

Compressed gases 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. Compressed gases also pose the health hazard of asphyxiation if their rapid expansion displaces oxygen. Some gases have additional hazards such as flammability, toxicity, reactivity and/or pyrophoricity (e.g. hydrogen, ammonia, fluorine, and silane, respectively); use of these elevated hazard gases is covered in the Hazardous Gas SOP in the Appendix of the CHP (Appendix B-14). All compressed gas cylinders must be stored with the safety cap in place when not in use. Cylinders must be stored either chained to the wall, chained in a cylinder storage rack, or secured by some others means to prevent tipping over. Flammable gas cylinders must be grounded and bonded to prevent explosions and fires.

A special subset of compressed gases are **cryogens** (e.g. liquid nitrogen). The primary risk to laboratory personnel from cryogens is frost burn of the skin and/or eye caused by contact with the material. In addition, nitrogen expands to nearly 700 times its original volume when changing from a cryogenic liquid to a room temperature gas. This means that relatively small spills can displace sufficient oxygen to cause asphyxiation. Because liquid nitrogen containers are at low pressure and have protective rings mounted around the regulator, they are not required to be affixed to a permanent fixture such as a wall. However, additional protection considerations should be addressed when storing liquid nitrogen in a laboratory. Always use appropriate thermally insulated gloves when handling liquid nitrogen. Face shields should be used, especially in cases where splashing can occur, or when cryovials are being removed as they may explode when warmed.

H-Code	Hazard Statement	Category
H280	Contains gas under pressure, may explode if heated	N/A
H281	Contains refrigerated gas, may cause cryogenic burns or injury	N/A
H282	Extremely flammable chemical under pressure: may explode if heated	1
H283	Flammable chemical under pressure	2
H284	Chemical under pressure: may explode if heated	3

2.3.2 Contact Hazard (Skin & Eye)

Contact hazards can affect the skin and/or eyes, and can be divided into three subcategories: **toxics, irritants, and sensitizers**.

Toxics (skin & eye), or toxicants, are chemicals which may cause toxicity as the result of an acute and/or chronic exposure(s) are considered toxic.

Irritants are chemicals that cause reversible inflammatory effects. A wide variety of organic and inorganic compounds, including many chemicals that are in a powder or crystalline form, are irritants. The most common example of an irritant may be ordinary smoke which can irritate the nasal passages and respiratory system. Consequently, eye and skin contact with all laboratory chemicals should always be avoided. Symptoms of exposure can include reddening or discomfort of the skin and irritation to eyes.

Sensitizers (allergens) are chemicals that cause exposed individuals to develop an allergic reaction in normal tissue after repeated exposure to the substance (e.g. activate an immune response). Examples of sensitizers include diazomethane, chromium, nickel, formaldehyde, isocyanates, arylhydrazines, benzylic and allylic halides, and many phenol derivatives. Sensitizer exposure can result in all symptoms associated with allergic reactions and/or can increase an individual's existing allergies.

H-Code	Hazard Statement	Category
H310	Fatal in contact with skin	1
H311	Toxic in contact with skin	1
H312	Harmful in contact with skin	2
H315	Causes skin irritation	2
H319	Causes serious eye irritation	2
H370	Causes damage to organs	3
H371	May cause damage to organs	3

2.3.3 Corrosives

As a health hazard, corrosive substances cause destruction of, or alterations in, living tissue by chemical action at or near the site of contact.

As a physical hazard, corrosive substances may degrade materials they come in contact with and may be violently reactive with other substances. It is important to review information regarding the materials they may corrode, and their reactivity with other substances, as well as information on health effects. In most cases, these materials should be stored in chemically compatible secondary containers and must be segregated from other classes of materials (e.g. store acids separately from bases or water-reactive materials).

Major classes of corrosive substances include:

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

Symptoms of exposure via inhalation include a burning sensation, coughing, wheezing, laryngitis, shortness of breath, nausea, and vomiting. For exposure to the eyes, symptoms include pain, blood shot eyes, tearing, and blurring of vision. For exposure to the skin, symptoms may include reddening, pain, inflammation, bleeding, blistering and burns. Materials which are corrosive to tissue should always be stored below eye level to reduce the likelihood of splashes into the eyes.

H-Code	Hazard Statement	Category
H290	May be corrosive to metals	1
H314	Causes severe skin burns and eye damage	1A, 1B, 1C
H318	Causes serious eye damage	1

2.3.4 Delayed Health Hazards

Delayed Health Hazards are chemicals that may cause adverse health effects over repeated or prolonger exposures after inhalation, ingestion or skin/eye contact and includes **sensitizers, carcinogens, and specific-target organ toxicity**.

Sensitizers (allergens) are chemicals that cause exposed individuals to develop an allergic reaction in normal tissue after repeated exposure to the substance (e.g. activate an immune response). Examples of sensitizers include diazomethane, chromium, nickel, formaldehyde, isocyanates, arylhydrazines, benzylic and allylic halides, and many phenol derivatives. Sensitizer exposure can lead to all of the symptoms associated with allergic reactions or can increase an individual's existing allergies. These can be dermal or respiratory sensitizers.

Carcinogens are chemical or physical agents that cause cancer. Generally, they exhibit chronic toxicity; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period. Chronic toxins are particularly insidious because they may have no immediately apparent harmful effects. Carcinogens are indicated under GHS by the health hazard pictogram and a hazard statement which includes the word "cancer". **Mutagens** are a subclass and are materials that can cause a change (or mutation) in the genetic material of a living cell. Such mutations can play a significant role in the development of cancer.

Specific Target Organic Toxins in this hazard class are substances which cause damage to target organs These include:

- Hepatotoxins: substances that damage the liver (e.g. nitrosamines, carbon tetrachloride)
- Nephrotoxins – substances that damage the kidneys (e.g. certain halogenated hydrocarbons)
- Neurotoxins – substances that damage the nervous system (e.g. mercury, acrylamide, carbon disulfide)
- Hematopoietic agents – substances that decrease hemoglobin function and deprive the body tissues of oxygen (e.g. carbon monoxide, cyanides)
- Respiratory Toxicants – Substances that damage lung tissue (e.g. asbestos, silica)

H-Code	Hazard Statement	Category
H317	May cause an allergic skin reaction	3
H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled	1, 1A, 1B
H350	May cause cancer	1A, 1B
H351	Suspected of causing cancer	2
H370	Causes damage to organs through prolonged or repeated exposure	1
H371	May cause damage to organs	2

H372	Causes damage to organs through prolonged or repeated exposure	1
H373	May cause damage to organs through prolonged or repeated exposure	2

2.3.5 Developmental & Reproductive Toxins

Developmental & reproductive toxins include any chemical that may affect the fetal development and/or reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis). This also includes **mutagens**, which are materials that can cause a change (or mutation) in the genetic material of a living cell. Such mutations can lead to reproductive toxicity. They can affect the reproductive health of both men and women if proper procedures and controls are not used. For women, exposure to them during pregnancy can cause adverse effects on the fetus; these effects include embryolethality (death of the fertilized egg, embryo or fetus), malformations (teratogenic effects), and postnatal functional defects. For men, exposure can lead to sterility.

Examples of embryotoxins include thalidomide and certain antibiotics such as tetracycline. Women of childbearing potential should note that embryotoxins have the greatest impact during the first trimester of pregnancy. Because a woman often does not know that she is pregnant during this period of high susceptibility, special caution is advised when working with all chemicals, especially those rapidly absorbed through the skin (e.g., formamide). Pregnant women and women intending to become pregnant should consult with their laboratory supervisor and their physician before working with substances that are suspected to be reproductive toxicants. OH also provides pregnancy consultations, with assistance and chemical expertise from RLSS, upon request.

H-Code	Hazard Statement	Category
H340	May cause genetic defects	1A, 1B
H341	Suspected of causing genetic defects	2
H360	May damage fertility or the unborn child	1A, 1B
H361	Suspected of damaging fertility or the unborn child	2
H362	May cause harm to breast-fed children	N/A

2.3.6 Explosives

Explosive substances are materials that decompose under conditions of mechanical shock, elevated temperature, or chemical action, and release large volumes of gases and heat. These substances pose an immediate potential hazard and procedures which use or produce them must be carefully reviewed. These materials must be stored segregated from other materials in a fire-resistant storage cabinet or, in many cases, in a laboratory grade refrigerator or freezer that is designed for storing flammable and reactive chemicals.

H-Code	Hazard Statement	Category
H200	Unstable Explosive	N/A
H201	Explosive; mass explosion hazard	Div 1.1
H202	Explosive; severe projection hazard	Div 1.2
H203	Explosive; fire, blast or projection hazard	Div 1.3
H204	Fire or projection hazard	Div 1.4
H205	May mass explode in fire	Div 1.5
H240, H241	Heating may cause an explosion	Type A, B

2.3.7 Flammables

Flammable chemicals include those chemicals that have a flashpoint of less than 100 °F. These materials must be stored in flammable storage cabinets if aggregate quantities of ≥10 gallons/room in the lab and/or the size of any individual container is ≥1 gallon (~4 L). 100% cotton or flame-resistant laboratory coats must be worn when working with large quantities of flammable materials and/or with procedures where a significant fire risk is present (e.g., when working with open flame). These can constitute a significant immediate threat and should be treated with particular care, even though their use is common in the laboratory setting. Attention should be given to preventing static electricity and sparks when handling flammable liquids.

Pyrophoric chemicals are a special classification of flammable materials with autoignition temperatures <130 °F and may spontaneously combust upon contact with air. Use of pyrophorics requires laboratory-specific training and an SOP. They should be handled within a glove box whenever possible. **The ordering, use, and storage of pyrophoric gases must be approved by RLSS; contact RLSS at 520-626-6850 or RLSS-help@arizona.edu**. Flame-resistant laboratory coats must always be worn when working with pyrophoric chemicals. Avoid using latex or nitrile gloves because they do not self-extinguish upon removal from an open flame. Chloroprene gloves, coupled with flame resistant glove liners, are highly recommended when handling pyrophorics outside of a glove box.

H-Code	Hazard Statement	Category
H206-H208	Fire or projection hazard.	1, 2, 3, 4
H220, H221	Extremely flammable gas or flammable gas	1A, 1B, 2
H222, H223	Extremely flammable aerosol or flammable aerosol	1, 2
H224	Extremely flammable liquid and vapor	1
H225	Highly flammable liquid and vapor	2
H226	Flammable liquid and vapor	3
H228	Flammable solid	1
H229	Pressurized container, may burst if heated	1, 2, 3
H230	May react explosively even in the absence of air	1A
H231	May react explosively even in the absence of air at elevated pressure and/or temperature	1A
H232	May ignite spontaneously if exposed to air	1A
H241	Heating may cause a fire or explosion	Type B
H242	Heating may cause a fire	Type C, D

2.3.8 Highly Reactives

Highly reactive chemicals are chemicals that present significant physical hazards due to their propensity to react with themselves, water, air, shock and/or friction. This list includes self-reactive, water-reactive, and shock/friction sensitive chemicals. It also includes chemicals that may form peroxide compounds, which are themselves highly reactive.

Water-reactive chemicals can evolve flammable or toxic gas when they encounter aqueous solutions or atmospheric moisture. This reaction may also produce enough heat to ignite any flammable gases thus generated. Water-reactive chemicals must be stored in tightly sealed containers in a cool, dry place away from any potential water sources. They should also be stored away from acidic materials which could act as a source of protons and cause the evolution of the same gases.

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 during inspection. Specific guidelines for allowable storage limits of opened containers of peroxide forming chemicals are available on the RLSS website.

H-Code	Hazard Statement	Category
H230	May react explosively even in the absence of air	1A
H231	May react explosively even in the absence of air at elevated pressure and/or temperature	1A
H232	May ignite spontaneously if exposed to air	1A
H241	Heating may cause a fire or explosion	1
H242	Heating may cause a fire	2
H250	Catches fire spontaneously if exposed to air	1
H251	Self-heating; may catch fire	2
H252	Self-heating in large quantities; may catch fire large quantities	2
H260	In contact with water releases flammable gases which may ignite spontaneously	1
H261	In contact with water releases flammable gases	2, 3

2.3.9 Inhalation Hazards

Inhalation hazards are chemicals that may be hazardous via inhalation. While this class ranges from chemicals that are irritating, harmful, toxic and fatal as well as chemicals that cause, or may cause, damage to organs after inhalation.

H-Code	Hazard Statement	Category
H330	Fatal if inhaled	1
H331	Toxic if inhaled	1
H332	Harmful if inhaled	2
H335	May cause respiratory irritation	2
H336	May cause drowsiness or dizziness	2
H370	Causes damage to organs	3
H371	May cause damage to organs	3

2.3.10 Ingestion Hazard

Ingestion hazards are chemicals that may be hazardous upon ingestion of the chemical. Direct ingestion of a hazardous chemical in a laboratory setting is highly unlikely; exposure typically occurs when someone touches their mouth with contaminated hands or ingests food or drink that has become contaminated with a chemical. These can be irritating, harmful, toxic, fatal, or can cause, or may cause, damage to organs after ingestion. A unique feature is that it also includes chemicals that act as an aspiration hazard (may be fatal if swallowed and the chemical enters the airways).

H-Code	Hazard Statement	Category
H300	Fatal if swallowed	1
H301	Toxic if swallowed	1
H302	Harmful if swallowed	2
H304, H305	May be fatal if swallowed and enters airways	2
H370	Causes damage to organs	2
H371	May cause damage to organs	3

2.3.11 Oxidizers

Oxidizers (e.g., hydrogen peroxide, potassium dichromate, sodium nitrate) are substances that cause or contribute to combustion of other materials by giving up oxygen atoms. Oxidizers should be stored in a cool, dry place and kept away from flammable and combustible materials, such as wood, paper, Styrofoam, plastics, flammable organic chemicals, and away from reducing agents, such as zinc, alkaline metals, and formic acid.

H-Code	Hazard Statement	Category
H270	May cause or intensify fire; oxidizer	1
H271	May cause fire or explosion; strong Oxidizer	1
H272	May intensify fire; oxidizer	2, 3

2.4 Hazard Communication Requirements

All laboratories using or storing hazardous chemicals are required to maintain the following information and labels to be compliant with OSHA regulations and these Hazard Communication Requirements.

2.4.1 Chemical Inventory

Every laboratory using hazardous chemicals must maintain an up-to-date inventory of the hazardous chemicals used or stored in each laboratory (room by room) within the online RLSS User Dashboard. These inventories must include the following information:

- The full chemical or product name. Mixtures of hazardous chemicals must be inventoried by listing all the components and their concentrations as well as the matrix solvent.
- The Chemical Abstracts Service (CAS) number, as these are unique identifiers which may help when there are multiple, or confusing, chemical names.
- The storage location where the hazardous chemical is normally kept.
- The maximum quantity expected to be present in the laboratory at any one time (e.g. 5 gallons, 2 kilograms, 500 milliliters, etc.).
- Chemical "Kits" with any identified hazards (look for GHS pictograms on the Kit box/container) must be included in the inventory.

The hazardous chemical inventory must be updated regularly; **RLSS recommends monthly or quarterly**. New hazardous chemicals should be promptly added to the inventory when they are acquired. Similarly, chemicals should be removed from the inventory when they are no longer expected to be in use/storage.

The RLSS online User Dashboard hazardous chemical inventory interface allows for any laboratory worker to update their laboratory's hazardous chemical inventory in real time. Once a laboratory enters its chemical inventory into this system, the User Dashboard automatically provides the hazard information, relevant (M)SDSs, and GHS-compliant container labels for each chemical. Laboratory workers can request the addition of a chemical or "Kit" to the RLSS Chemical Database by emailing RLSS at rlss-chem-support@arizona.edu; be sure to include the chemical name, CAS number, manufacturer, and (if available) Safety Data Sheet (SDS). Once this chemical is available in the database, the AH/ASC or designee must add the chemical to the laboratory inventory through the User Dashboard.

2.4.2 Safety Data Sheets (SDS)

An SDS provides information on the characteristics and hazards of a chemical. This information includes the hazard statements, pictograms and precautionary statements related to a chemical. The GHS SDS provides a common format for relaying the hazard information about a chemical in the United States and internationally.

Every AH must have an SDS **readily** available for every hazardous chemical that may be used or stored in their laboratory/laboratories. **As long as the hazardous chemical inventory is kept up to date through the RLSS User Dashboard, this requirement is met**. If a chemical is in the

RLSS Chemical Database, but it does not have an associated SDS, or if a different (M)SDS is needed, the AH/ASC or designee should complete the "SDS Database Addition Request Form" to request the addition of a SDS to the database; this form can be found on the RLSS website.

For more information on the requirements of SDS, visit the OSHA Hazard Communication website.

2.4.3 Hazardous Chemical Container Labels

All chemical containers in a laboratory must always be properly labeled . This includes containers of non-hazardous chemicals (e.g. distilled water) to avoid confusion and potential injury and/or illness in the laboratory. Labels must be legible, in English and prominently displayed. Labels from the manufacturer must remain on all containers and must not be defaced in any way until emptied. **All original containers of hazardous chemicals from the manufacturer must be labeled with GHS information:**

- The identity of the substance
- All applicable warning statements
- Pictograms
- A signal word
- Precautionary statements
- The name and address of the manufacturer or other responsible party

In addition to the required information, many manufacturers, distributors and importers may include supplementary information including recommended protective apparel, safe handling procedures, first aid procedures, physical data and storage requirements.

These required label elements apply to newly acquired chemical container labels only; laboratories are not required to re-label old chemical container labels with GHS information. If chemicals are moved from the manufacturer-provided container to a secondary container (i.e. vials, spray bottles, mixture containers), **the secondary container must be labeled with at least two of the required GHS label elements listed above. Laboratories can print GHS-compliant labels for older primary containers and secondary containers from the RLSS User Dashboard hazardous chemical inventory.**

- The RLSS User Dashboard inventory is designed to print labels on Avery GHS labels or standard paper (tape onto container).
- For more information on how to create a GHS-compliant chemical container label, see the "Chemical Label Generation from RLSS User Dashboard" on the RLSS website.

2.4.4 Room Signage

Every laboratory using hazardous chemicals must obtain a Combined Laboratory Hazard Communication Posting from RLSS. This posting will be placed near the entrance to all laboratory areas from non-laboratory areas so all entrants can view a summary of the radiological, biological and chemical regulated hazardous materials present. The posting will include the applicable GHS hazard pictograms relating to the laboratory's overall online chemical inventory to warn entrants about what hazards are present inside the laboratory. RLSS is responsible for providing the

laboratory signs, and the AH/ASC is responsible for maintaining this posting at each entrance to every laboratory in which hazardous chemicals are used and/or stored.

Contact RLSS for a replacement if the postings no longer reflect the hazards present within the lab and/or become illegible.

2.4.5 Storage Area Labels

Certain chemical storage areas may require specific warning labels, depending on the types of hazardous chemicals present in the laboratory. Contact RLSS or visit the RLSS website to print any of the following required labels:

- Flammable cabinets must be labeled with the GHS flammable pictogram and the words "Flammable – Keep Fire Away."
- All particularly hazardous chemicals must be used and stored within an area designated for that purpose. Each storage and use location for particularly hazardous chemicals must be labeled with the "Designated Area Label," found on the RLSS website. The label must be affixed either to the door of a designated area room, visible within the experimental/storage area or on a designated piece of equipment.
- All laboratory refrigerators, freezers, microwaves and any other device that could be used for the storage, preparation and human consumption of food or drink must be posted with a "No Food or Drink" label.
- Storage areas for other chemical hazards (e.g. oxidizers, acids, bases, etc.) may be posted with warning labels in the laboratory.

3. Standard Operating Procedures

3.1 University SOPs (USOPs)

USOPs (see appendices) provide more detailed information about the safe use of hazardous chemicals in different situations. All laboratory workers at UArizona must comply with any USOPs that apply to their work with hazardous chemicals. The hazards, control measures, spill/exposure procedures and waste disposal requirements for each GHS chemical Hazard Class are described within each specific Hazard Class' USOP found within this plan. Other USOPs in this plan include "Unattended Reactions," "Proper Use of a Chemical Fume Hood" and "Use of Particularly Hazardous Chemicals in Animals." All USOPs are included in Appendix B of this plan; they are also available as separate documents on the RLSS website.

3.2 Laboratory SOPs (LSOPs)

Some procedures are specific to a laboratory and may need special/alternative measures to control hazards that are either not adequately defined within the applicable USOP(s). These types of procedures must be documented within LSOPs to address the specific chemical hazards and situations expected in the laboratory. LSOPs may be required for the use of hazardous chemicals with their own OSHA vertical standard (49 CFR 1900.1001 – 1910.1052), or those that carry a medical surveillance requirement. Examples of such chemicals include formaldehyde, benzene, mercury, methylene chloride and lead. LSOPs may also be required for specialized procedures or equipment in the laboratory that may present a unique hazard to laboratory workers (toxic/hazardous compressed gases), or that are meant to mitigate hazards presented to laboratory workers.

All LSOPs must be included in the Approval's LCHP that is published on the RLSS online User Dashboard. Their relevance and effectiveness **must be evaluated annually**, with the rest of the LCHP. See the RLSS website for an LSOP template.

4. Limiting Exposure

A wide variety of chemicals may be present in a laboratory, presenting many different hazards to a laboratory worker. Exposure to these hazards must be controlled to reduce the risk of chemical-related injury or illness. RLSS works through regularly scheduled inspections and providing additional requested assessments to determine appropriate methods of controlling exposure to hazardous chemicals. RLSS also assists with the implementation of recommended control measures; contact RLSS to assess the hazards and required control measures presented by a new chemical or process.

4.1 Chemical Exposure

Laboratory workers can be exposed to hazardous chemicals in a variety of ways. The most common routes of entry for a chemical into the body in the laboratory are:

1. Inhalation
2. Absorption (through the skin or eyes)
3. Ingestion
4. Injection (uptake of material through an open wound or the skin being punctured by a contaminated sharp object or needle)

Inhalation is the most common route of exposure in the laboratory. However, exposure to one chemical can occur through multiple routes at the same time (e.g. a spill of acetone may absorb through your skin and be inhaled). The route of exposure will depend on the physical form of the chemical (i.e. solid, liquid, gas), its concentration, and how the chemical is being used (i.e. heating, grinding, mixing).

Once a chemical enters the body, it can have different effects depending on its toxicity and reactivity. Health effects are typically categorized according to their type of exposure:

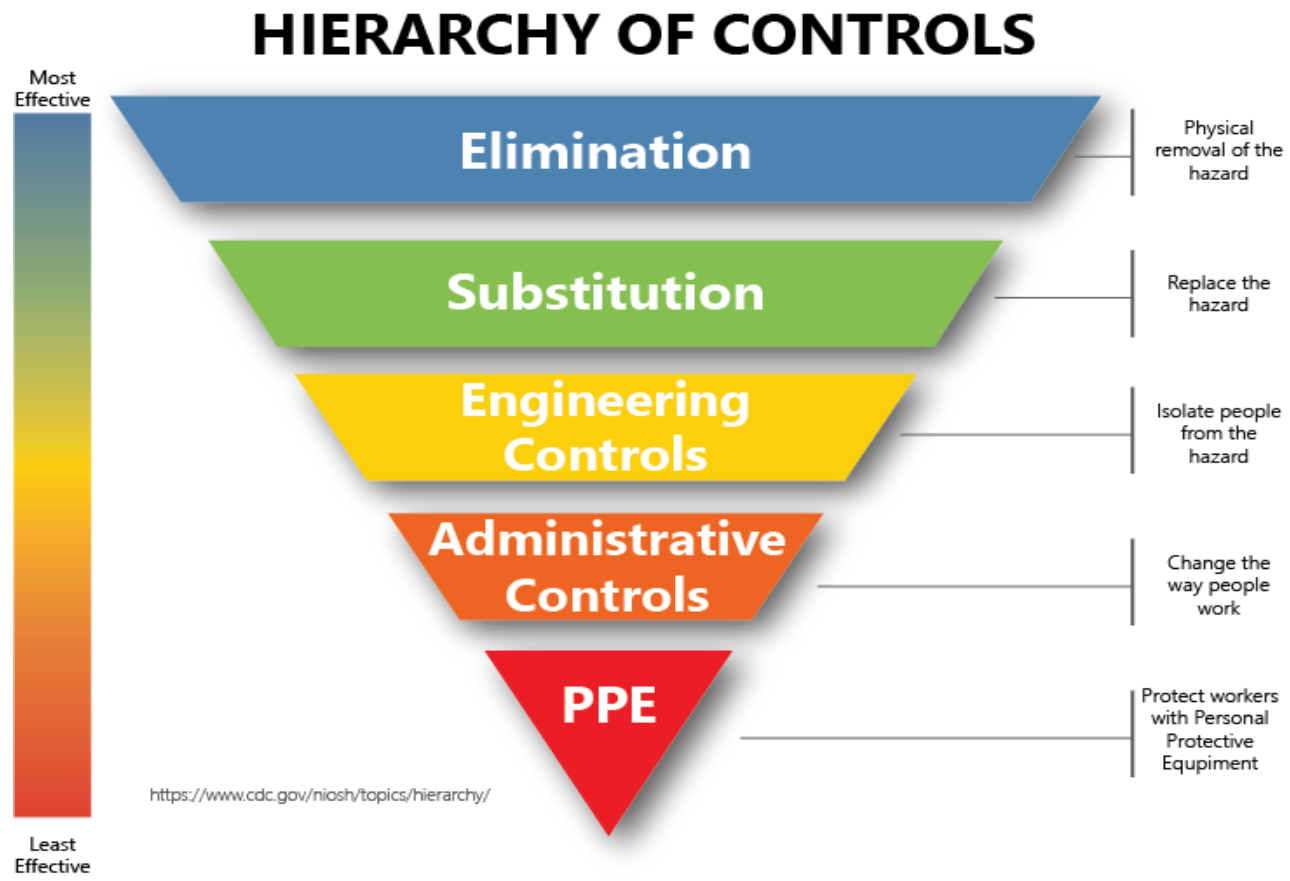
- Acute exposure: Acute effects occur from a sudden and severe exposure to hazardous chemicals. They are often reversible (e.g. carbon monoxide or cyanide poisoning).
- Chronic exposure: Chronic health effects occur from prolonged or repeated exposure; this can occur over days, months, or even years. The symptoms of chronic effects may be delayed, and they are often irreversible (e.g. mercury poisoning and cancer development).

Hazardous chemicals may also present physical hazards, such as a fire or explosion. When a person is exposed to multiple chemicals at one time, these chemicals may combine to form different health and physical hazards. Chemicals in combination may have increased toxicity, the same toxicity, or in some cases, decreased toxicity. When working with multiple chemicals where the combined effect is unknown, you should always assume the health or physical hazards of the combination are greater than the individual chemical hazards.

4.2 Controlling Chemical Hazards

Limiting exposure to hazardous chemicals can generally be accomplished by following the hierarchy of control measures shown in the figure below. When looking at this figure, the controls

on the top of the pyramid are potentially more effective than those at the bottom. However, those towards the bottom of the pyramid are used more frequently in the laboratory. In most situations, some combination of all methods is necessary to control chemical hazards.



Credit: National Institute of Occupational Health and Safety (NIOSH)

4.3 Elimination / Substitution

The **most effective method of avoiding exposure to a chemical hazard is to eliminate, or remove, that hazardous chemical from the laboratory**. Substitution for a less hazardous chemical is also effective in removing a hazard from the laboratory, as the original hazard is no longer present. Various websites exist that suggest potential substitutes for harmful chemicals, such as the Environmental Protection Agency. Vendors also produce lists of potential substitutes, such as Fisher Scientific.

While the elimination or substitution of a hazard are the most effective control measures to implement in a laboratory, they may be the most difficult to achieve. When elimination or substitution is not possible, the three remaining control measures are relied on to decrease the risk of exposure.

4.4 Engineering Controls

Engineering controls are typically built into the design of a laboratory and are high on the hierarchy of controls because they do not require active participation but are able to passively protect the user from hazards. These controls can include modifications to equipment, ventilation systems and processes, all of which are designed to prevent the source of exposure from reaching a worker. When properly maintained, engineering controls can be highly effective in protecting laboratory workers from a hazard, and typically require minimal special procedures or actions from the laboratory worker.

While the cost of installing engineering controls may be higher than implementing administrative controls or buying personal protective equipment, the operational and lifetime costs are usually lower than providing personal protective equipment (PPE) to avoid exposures over the long term.

4.4.1 General Ventilation

General ventilation allows for outside air to be brought into a space, diluting the inside air and reducing laboratory worker exposure to airborne hazards. All laboratories must be negatively pressured in relationship to the hallways or adjacent rooms; air must be flowing from the hallway or adjoining rooms into the laboratory to keep hazardous atmospheres from entering public spaces.

Ideally, general ventilation should completely replace the inside air **at least 6 times per hour (air exchanges per hour, ACH)** to prevent the buildup of potentially hazardous atmospheres; and considered a “well-ventilated area.” Such ventilation is not always possible, especially in older buildings and leased properties. Hazardous chemical use laboratories must at least constitute a “ventilated area,” in which there is some measurable air movement in the laboratory. If a laboratory does not constitute a “ventilated area,” RLSS may restrict the use of certain chemicals if the laboratory cannot, at minimum, be classified as a “passively ventilated area” because it allows air movement by opening windows, activating fans, etc. Laboratories should be negatively pressured relative to the outside, meaning that air flows into the lab from corridors/outside; this is to prevent those outside of the lab from exposure to hazardous chemicals.

Proper airflow in a building is the responsibility of the University or leasing landlord, not of the researchers in the laboratory. However, building ventilation measurements and certifications are made with the assumption that all laboratory doors are kept closed; **it is the responsibility and expectation that laboratory doors will kept closed/not be propped open expect in unique and approved cases**. RLSS will assess general ventilation for adequacy upon request and in conjunction with Facilities Management HVAC experts.

4.4.2 Chemical Fume Hoods

General building ventilation may not be sufficient for controlling all laboratory hazardous atmospheres. Local exhaust ventilation can be used to remove hazardous dusts, fumes, mists, aerosols, gases, and vapors by exhausting air at their source, rather than diluting them with supplied air. Chemical fume hoods are the most common local exhaust system used on campus, removing hazards from the laboratory through the building's local ventilation system.

Chemical fume hoods must be used for any particularly hazardous chemicals that present an inhalation hazard and must be considered for procedures using hazardous chemicals that may result in the release a fume, mist, gas, vapor, dust, some mists, etc. Contact RLSS for assistance and hazard assessments necessary to determine what your potential exposure may be and if a fume hood is required. Fume hoods are very effective at minimizing exposure to hazardous chemicals but are not able to protect workers from biohazards or biological materials from contamination by workers.

The annual maintenance and calibration of fume hoods is the responsibility of Facilities Management, leased space landlord or a satellite facility contractor. Chemical fume hoods should be inspected outside of the annual inspection process upon installation, renovation, when a deficiency is reported, or a change has been made to the operating characteristics of the hood. Each fume hood must have a current calibration sticker and a marker indicating the highest sash height to be used when working with hazardous materials. Fume hoods should be installed with at least one qualitative air flow or face velocity monitoring device that will sound an alarm when dipping below acceptable protection levels. It is the responsibility of the AH to ensure the fume hood is used properly, and to notify Facilities Management or their facility coordinator when maintenance is required at 520-621-3000. **Refer to the "*Proper Use of a Chemical Fume Hood*" USOP in Appendix B for additional information on the use and maintenance of a fume hood.**

4.4.3 Biosafety Cabinets (BSCs)

The vast majority of BSCs are not designed to be used with hazardous chemicals nor to protect workers from chemical hazards. The air circulation patterns that protect works and samples may actually cause significant physical and health risks due to the build-up of chemical vapors in the head space of a BSC; there have been documented chemical exposures, fires, and even explosions when using certain chemicals in BSCs. **RLSS must be contacted to assess hazards and approve BSC use in conjunction with hazardous chemical work**.

4.4.4 Local Exhausts

Snorkels, or "elephant trunks," and canopy hoods are local exhaust systems that may capture hazardous dusts, vapors or gases produced in small areas or by individual instruments. They generally are less effective than chemical fume hoods, since their contaminant capture zone is only local/proximal to the placement of the device and they are truly designed for the removal of heat around high temperature equipment. Contact RLSS to assess if a particular local exhaust is appropriate and/or adequate to capture the contaminant(s) of concern.

4.4.5 Glove Boxes/Glove Bags

Some laboratories use contained and/or ventilated glove boxes for working with known carcinogens and highly toxic chemicals, or to provide a complete containment and an inert atmosphere when working with environmentally sensitive compounds (pyrophorics or other air-reactives). Glove boxes may be required to exhaust through the building's local ventilation system. These units can be very effective in controlling hazards, as they offer complete containment. However, they require a larger amount of maintenance and special procedures than chemical fume hoods for the laboratory worker. While less effective, disposable glove bags are a cheaper alternative to a glove box for short-term usage.

4.4.6 Gas Cabinets

A gas cabinet is a contained storage device that connects to a local exhaust system, allowing for the removal of hazardous vapors or gases before laboratory workers are exposed. These also contain potential physical hazards, such as explosions, from propagating throughout a space. Gas cabinets should be used to house hazardous gas cylinders; in some cases, they may be the only option for the storage of certain types or quantities of a cylinder. Per Fire Code regulations, a hazardous gas with an NFPA health rating of 3 or 4 in a gas cylinder larger than a lecture bottle must be stored in and piped from a gas cabinet, not a chemical fume hood. Gas cabinet effluent may be required to be scrubbed (physically or chemically) in order for the University to maintain compliance with air quality rules and permits.

For more information on requirements, please refer to Appendix B, Hazardous Gases SOP and contact RLSS. Gases that must reside in gas cabinets must be approved for purchase, storage, and use by RLSS.

4.4.7 Flammable Cabinets/Refrigerators

Fire code (NFPA and IFC) stipulates strict limits on the quantities of flammable chemicals that are permitted to be stored outside of an approved flammable cabinet as well as within a cabinet or lab space. Flammable cabinets, yellow steel cabinets, work to protect flammable liquids against flash fires and contain spilled chemicals that can further spread fire. Flammable cabinets must have built-in spill containment and self-closing hinges with a 3-point latch. Non-approved cabinets being temporarily used for the storage of flammable chemicals must have a Flammable Pictogram and Warning label affixed in a visible area, which can be found on the RLSS website.

The NFPA limits storage of flammable cabinets within a laboratory based upon their flammability code (ex. Flammable class IA chemicals outside a flammable cabinet or flammable refrigerator cannot exceed 10 gallons). The flammability code of a chemical can be found on the chemical's Safety Data Sheet. Approved flammable cabinets may be found under chemical fume hoods or as stand-alone storage cabinets. Per fire code, no more than 60 gallons of flammable liquids may be stored inside a single flammable cabinet and no more than 10 gallons of flammable liquids outside of a flammable cabinet. Please see the following table from "Making Sense of Laboratory Fire Code" by the American Institute of Chemical Engineers (AIChE) for more details on the limitations of flammable liquid use and storage.

Table 2. NFPA 45 limits the quantity of liquids that can be used and stored in a laboratory based on fire hazard class.

Fire Hazard Class	Material Class*	Maximum Quantity in Use, gal		Maximum Quantity in Use and Storage, gal	
		per 100 ft^2	per Lab	per 100 ft^2	per Lab
A — High Fire Hazard	I	10	480	20	480
	I, II, IIIA	20	800	40	1,600
B — Moderate Fire Hazard	I	5	300	10	480
	I, II, IIIA	10	400	20	800
C — Low Fire Hazard	I	2	150	4	300
	I, II, IIIA	4	200	8	400
D — Minimal Fire Hazard	I	1	75	2	150
	I, II, IIIA	1	75	2	150

*Material Class I encompasses Class IA, IB, and IC materials. NFPA 45 does not place limits on Class IIIB materials.

Table from "Making Sense of Laboratory Fire Code" by AIChE.

No more than three approved flammable cabinets may be located in a single room, unless approved by the University Fire Marshal (please contact RMS at 520-621-1790 for assessment by the Fire Marshal). Further information on inside storage rooms may be found in the OSHA 29 CFR 1910.106 Standard.

Flammable liquids must not be stored in an unmodified domestic refrigerator in quantities exceeding 500 mL; many sources of ignition exist within them, including the light bulb. Cold rooms must also be designed without potential ignition sources if they are to be used for flammable liquid storage. A refrigerator or cold room used for the storage of flammable or combustible liquids needs to be "explosion-proof," "laboratory-safe," or a "modified domestic" model. Flammable refrigerators are regulated by the same storage limits as flammable cabinets. Cold rooms are designed to recirculate the air contained within; thus flammables can vaporize, accumulate, and pose an inhalation and/or an explosion hazard. Cold rooms have fans and

electrical laboratory equipment that are potential ignition sources and large quantities (>500 mL) of flammable solvents must NOT be stored in cold rooms, much like refrigerators.

4.4.8 Corrosive Cabinets

Special plastic or plastic lined cabinets with compatible secondary containment should be used for the storage of corrosive chemicals. Ensure that acid and base corrosives are segregated from one another by physical storage area or secondary containment.

4.4.9 Guarded Scales

Guarded scales, those enclosed by barriers that surround the taring surface, can be effective at controlling exposures to finely powdered substances during the weighing process. Those using guarded scales should enhance hygiene practices (using a wet cloth to wipe down the area if it is compatible with the chemical in use, disposable surface barriers, disposable weigh boats, secondary containment, etc.) on the guarded scales themselves (interior and exterior surfaces), as well as the surrounding areas. There should be no visible powders left within or upon the guarded scale and/or on surfaces/equipment proximal to the scale.

4.4.10 Other Safety Equipment

AHs must ensure that safety equipment other than that mentioned above is inspected and maintained by Facility owners, Facilities Management and/or the laboratories at a frequency which is recommended by the manufacturer and/or a frequency which will ensure their proper and safe functioning. A description of such safety equipment must also be included in the LCHP. Examples of such equipment include gas monitors, safety shields, etc.

4.5 Administrative Controls

Administrative controls can limit worker exposure to hazardous chemicals through **changes in the behavior of workers; these can be effective but are less desirable than the preceding controls because it requires active participation instead of passive controls.** Common administrative controls are:

- Limiting the amount of time a worker is exposed to a hazardous chemical
- Properly planning an experiment or procedure before starting it
- Creating written policies and procedures
- Exposure monitoring

Planning the details of an experiment before starting will decrease the amount of time spent handling hazardous chemicals. Planning a process before commencing should always be done and can help minimize the amount of hazardous chemicals being used. Exposure monitoring will alert the AH when laboratory workers are exposed to chemicals above allowable limits; contact RLSS for monitoring and assessment.

Safety-related policies and procedures are administrative controls. They may define training requirements, specific hazard controls, equipment maintenance, personal hygiene practices, etc. AHs are responsible for the creation, review and annual update of the LCHP and LSOPs. RLSS

publishes both this plan (including USOPs) and each laboratory's LCHP (including LSOPs) on the User Dashboard. These plans and procedures help laboratory workers understand potential hazards in their work, as well as what control measures (i.e. use of the "buddy system", lab security practices, accepted work hours, robust employee onboarding) are available to protect them. All laboratory workers under an Approval will be able to access these documents on the RLSS online User Dashboard; each worker must read both plans and use the online system to affirm that they understand the information within the documents.

Administrative controls are generally less effective than elimination/substitution and engineering controls; the hazard is not actually being removed or reduced, only controlled. The effectiveness of administrative controls depends on the awareness, training and compliance of the people utilizing them. When used correctly, however, administrative controls effectively address the human element of hazard controls.

4.6 Personal Protective Equipment (PPE)

PPE serves as a last line of defense against exposure to chemical hazards and is required for everyone working with hazardous chemicals. However, PPE alone should never be relied upon to provide adequate protection against hazardous chemicals; it can easily "fail" and stop protecting the laboratory worker, sometimes with little or no warning. An example of PPE failure is the breakthrough of chemicals through examination gloves, clothing and even scrubbing or respirator cartridges.

Every person working in a UArizona research laboratory with hazardous chemicals must wear the following PPE, whether working directly with hazardous chemicals or working near hazardous chemical use:

- Closed-toed shoes (liquid-impervious material is highly recommended);
- Full-length leg covering (whether pants, dress, socks & pants, etc.);
- Laboratory coat (100% cotton required for flammable chemical use);
- Safety goggles;
    - Glasses are acceptable some chemical use, but are designed to protect workers from impacts as opposed to chemical splashes, vapors, gases, mists, etc.
- Disposable examination-type gloves (nitrile or latex)
    - Additional gloves may be required for use with corrosives or specialty chemicals; ALWAYS consult an SDS for the appropriate glove prior to commencing work

All long hair, jewelry, clothing, and face coverings must be tied back or otherwise controlled to keep from being loose and interfering with required personal protective equipment. Work with your AH/ASC, RLSS, and/or the Disability Resource Center (DRC) to determine how to control loose clothing required by religion or medical condition (i.e. head/face covering, bandages, etc.).

Under OSHA regulation, it is the responsibility of the AH to provide adequate PPE to every laboratory worker at no cost to the worker. Students in a teaching laboratory are not considered "employees" and are responsible for adhering to the requirements of the class syllabus and may need to acquire their own PPE.

4.6.1 PPE Assessment and Selection

Appropriate PPE will depend on the chemical(s) being used, the hazards and routes of exposure associated with those chemicals, compatibility of the desired PPE material with the specific chemicals, and the length of time the PPE will come into contact with each chemical. The AH/ASC should give careful consideration to the comfort and fit of the PPE that will be provided in the laboratory to ensure it will be used effectively by laboratory workers. **The most effective PPE is the type that will actually be used/worn by employees.** All PPE must be kept in a sanitary and reliable condition. **Laboratory coats must never be taken home for cleaning; contract with a service, such as Shaffer's Dry Cleaning, for decontamination.**

AHs are required to update PPE requirements in their LCHP when new chemicals or activities require increased protection. Contact RLSS for assistance with hazard assessments when chemical use is changed.

In light of the COVID-19 pandemic, PPE should NOT be shared between workers unless absolutely necessary. Fabric items such as lab coats should never be shared, but easily decontaminated items like face shields may be cleaned and disinfected before and after use. Please contact RLSS for questions about PPE sharing.

4.6.2 Hand Protection (Gloves)

Gloves protect against chemicals that are easily absorbed through the skin. They also work to prevent eye contact and ingestion of chemicals, as the gloves keep hands free from contaminants and people are less likely to touch their faces with gloves on their hand. Nitrile and latex examination gloves are the most commonly used by laboratories, though other glove types may be more protective in certain situations. There are a few general rules that apply to all gloves, no matter the type:

- Inspect gloves for weather wear (i.e. brittleness, discoloration, adherence of gloves to one another), holes, cracks or contamination before use. Discard any gloves found to be inadequate or questionable.
- Replace gloves periodically (every 1-2 hours) during use; all glove materials are eventually permeated by chemicals. Manufacturers generally provide information on breakthrough and chemical compatibility.
- Discard disposable gloves immediately after each use or whenever they become contaminated, whichever occurs first.
- Rinse reusable gloves with soap and water, carefully remove them and allow them to dry completely for storage after each use.
- **Always remove gloves prior to leaving the laboratory.**
- Wash your hands thoroughly with soap and water after your gloves have been removed, and prior to leaving the laboratory.
- Remove of disposable gloves by grabbing the cuff of the left glove with the gloved right hand and removing the left glove. While holding the removed left glove in the palm of the gloved right hand, insert a finger under the cuff of the right glove and gently invert the right glove over the removed left glove.

- **Do not wear contaminated gloves when performing common tasks such as working on the computer, answering the phone, grabbing a door handle, using an elevator, etc**.
- Wear two pairs of gloves when working with particularly hazardous chemicals or hazardous chemicals that are easily absorbed through the skin.

Other than examination gloves, the following gloves may be required for laboratory hazardous chemical and physical hazards:

- Cryogenic gloves – For handling cryogens (e.g. liquid nitrogen), dewars, frozen samples and connecting compressed gas regulators.
- Autoclave gloves – For handling autoclaved materials, hot surfaces and connecting compressed gas regulators.
- Leather / Work gloves – For handling biting animals, connecting compressed gas regulators, and protection form sharp/glass hazards.
- Acid resistant gloves (e.g. neoprene or rubber, extended coverage) – For handling bulk corrosives/injurious materials.

4.6.3 Protective Clothing

Protective clothing includes laboratory coats, aprons, boots, shoe covers, gowns, and other items that can be used to protect the body and street clothes from hazardous chemical exposure. Some general rules exist for the proper use and maintenance of laboratory coats:

- Laboratory coats should cover the knees and have full-length sleeves. Sleeves should never be rolled above the wrist on a laboratory coat.
- Keep laboratory coats completely buttoned up. Snap closures are preferable over buttons or zippers to keep the body covered and allow quick removal in case of an emergency.
- Do not wear laboratory coats outside of the laboratory or take laboratory coats home.
- If laboratory coats become contaminated/dirty they should be professionally decontaminated or cleaned. Shaffer Dry Cleaning & Laundry provides a lab coat laundry service to UArizona researchers. To start service for your laboratory, call Shaffer at 520-318-2538. Further information can be found on the RLSS website.
    - If a laboratory coat is extremely contaminated, the structure compromised (e.g. torn, ripped, seams coming apart), it must be disposed of as dry hazardous material. **Do not continue to use a compromised laboratory coat.**
- **The useful life of a laboratory coat is typically one year or less.**

As with gloves, all types of laboratory coat material do not protect against the same hazards. 100% cotton or flame-resistant laboratory coats must be used when working with pyrophoric chemicals, high volumes of flammable chemicals, or flammable chemicals near an ignition source (e.g. Bunsen burner).

4.6.4 Eye and Face Protection

All laboratory workers and visitors should wear protective eyewear (i.e. safety goggles) while in any laboratory where chemicals are being used or stored, even when not working directly with chemicals. **Prescription eyeglasses do not constitute adequate protective eyewear**; however,

there are safety glasses and goggles that are designed to fit over eyeglasses. Additional face protection, such as splash goggles and face shields provide extra protection to the eyes and face and are required whenever using injurious corrosive chemicals. They should only be used in addition to safety glasses or goggles, never alone. As with all other forms of PPE, there are many options for eye and face protective equipment, each of which has different applications and limitations. Please contact RLSS for an assessment of your eyewear or for consultation on the appropriate type for your purposes.

4.6.5 Respiratory Protection

Respirators are generally not recommended for controlling chemical exposures in the laboratory environment. RLSS must be contacted if to schedule a hazard assessment and/or measurements to determine and document whether entrance into the Respiratory Protection Program (RPP), jointly administered by Risk Management Services (RMS) and UA Occupational Health (OH), is required. **OH will not proceed with enrollment into the University's RPP without authorization from RLSS; please read about the respiratory protection acquisition process online**. If a significant inhalation hazard is present in the laboratory, the suggested method of containing the hazard is through engineering controls, such as a chemical fume hood or local exhaust system, which remove the hazardous vapors, dusts, fumes, and gases from the breathing zone of the worker.

In some situations, however, respirators in a laboratory setting become necessary. These situations may include:

- An accidental spill of chemicals outside of the fume hood.
- Performance of an unusual operation that cannot be conducted under the fume hood or biosafety cabinet.
- Weighing hazardous powdered chemicals or microbiological media outside of a glove box or other protective enclosure (guarded scale).
- When exposure monitoring indicates exposure hazards that are not adequately controlled by engineering or administrative controls.
- As required by a specific laboratory protocol or as defined by applicable regulations.
- When directed by the Institutional Animal Care & Use Committee (IACUC) Animal Hazards Program for controlling exposure to animal allergens.

In some situations, respirator use is initiated on a voluntary basis by the worker, researcher or student in the laboratory. These respirator users must abide by the following respiratory protection program rules:

- Voluntary respirator use is limited to disposable filtering face piece "mask" type of respirators (e.g. N95). **Respirators that need a filtering cartridge, or that are tight fitting design (face sealing "gasket") are not allowed to be worn on a voluntary basis** and require full inclusion into the UArizona RPP.
- The voluntary respirator user must inform their Approval Holder and/or Approval Safety coordinator about their intention to bring their own respirator into the laboratory workplace on a non-mandated, voluntary basis.
- The Approval Holder and/or Approval Safety Coordinator must review the intended use of the respirator with the voluntary user in order to ensure that wearing the respirator will not

endanger (e.g. heat stress, ergonomics, visibility, communication) the user's health and safety in their workplace.

- The Approval Holder, Approval Safety Coordinator or voluntary respirator user can contact Risk Management Services for consultation about what respirator system would be ideal for their needs.
- The voluntary respirator user must complete the "Voluntary Respirator Use Form" (available on Risk Management Services website) and submit it to their Approval Holder and/or Approval Safety Coordinator who need to keep it on file in case of an inspection (RLSS or Arizona / Federal Occupational Safety and Health Department) event, or investigation.
- Voluntary respirator users, as per RMS and OH online program guidance, are not required to complete the medical evaluation examination requirement with OH or fit testing and training RPP requirement with RMS. However, they may not begin use of the respirator until voluntary respirator use form has been accepted by Approval Holder and/or Approval Safety Coordinator.

Due to the COVID-19 pandemic, the University does not authorize the use of N95s for voluntary use as a protective measure against COVID-19. Please read the policy online and contact RLSS with any questions.

There are numerous types of respirators available; each one has specific limitations and applications. Respirator use almost universally requires training and fit testing to a specific respirator model and size. Individuals working under a PI/Faculty chemical safety approval requiring a respirator must register into the UArizona RPP in order to use respirators in a laboratory; an assessment from RLSS is required for registration into UArizona RPP. After an assessment from RLSS, workers must complete an online medical evaluation form, which includes a medical questionnaire (see OH website for online form) and possible medical physical exam coordinated by OH, as well as training and a fit testing and training session with RMS or OH.

AHs must identify work requiring respiratory protection (with the aid of RLSS and/or RMS), send laboratory workers requiring respiratory protection to a fit testing on an annual basis and maintain the records of these fit tests in the laboratory. For further information about UArizona RPP, contact RMS and OH.

4.6.6 Face Coverings

Face coverings are NOT PPE, as they do not protect the wearer from exposures; instead, face coverings protect those around a wearer from exposure to their exhalations, sneezes, coughs, etc.

Due to the COVID-19 pandemic, RLSS has created a guidance document for utilizing face coverings in the laboratory. Please refer to the "Face Coverings in the Laboratory" guidance on Box; this document will continue to be updated as more information and research on face coverings, safety, and SARS-CoV-2 become available.

4.7 Hazardous Chemical Storage

Proper storage and segregation of chemicals is essential to maintaining a safe laboratory environment. All hazardous chemicals must be stored in a secured area, such as a locked laboratory or room within a laboratory. If hazardous chemicals must be stored outside of a secured laboratory, such as a refrigerator or cabinet in a hallway, other means of security must be implemented (i.e. a padlock).

4.7.1 General Storage Recommendations

Store chemicals in a specific location and return them to that location after each use. Common storage locations include flammable cabinets and refrigerators, corrosive cabinets, and laboratory shelves (see Section 7.1 for Controlled Substances storage requirements, see Section 7.3 for licensed explosive material storage). **Chemical fume hoods and biosafety cabinets should not be used for long-term storage of chemicals.** Overcrowding fume hoods may disrupt air flow and drastically decreases their efficiency in controlling a hazard. Hazardous liquids and corrosive chemicals should not be stored above eye level, storage areas should never be overcrowded (i.e. stacking hazardous chemicals upon one another), and chemicals should not be stored on their side.

Laboratory shelves should have a raised anti-roll lip, and all chemical containers in a storage area must be properly labeled with hazard information. Chemicals should only be alphabetized within each group of compatible chemicals. Chemicals should not be stored/used beyond their expiration date. If chemicals expire, have no anticipated use, have deteriorated, have questionable/illegible labels, are leaking, or have corroded caps, contact Risk Management Services for removal of the chemical as hazardous waste.

Solid chemicals should be segregated from liquid chemicals, and chemicals should not be stored underneath a sink, unless they are water-soluble cleaning solutions. Do not use or store chemicals or chemical waste in or near sinks. If it is necessary to store a hazardous chemical near a sink, it must be stored in secondary containment.

4.7.2 Quantity Limitations

Hazardous chemicals should be purchased in the smallest practical amount and lowest concentration necessary to accomplish planned work. They should only be dispensed at the bench top or in the chemical fume hood in the minimum amount necessary for immediate use. Quantities of explosives, organic peroxides, pyrophoric solids or liquids, unstable (reactive) chemicals, carcinogens, reproductive toxins, and highly toxic solids or liquids should be kept to a bare minimum.

Specific National Fire Protection Agency (NFPA)/International Fire Code (IFC) storage quantity limits exist for flammable liquids (Section 4.4.7) and hazardous gases (Section 7.2). RLSS may defer or coordinate laboratory concerns regarding IFC regulations though the University Fire Marshal at Risk Management Services.

4.7.3 Chemical Segregation

Hazardous chemicals must be stored, segregated, or separated according to compatibility so that they cannot accidentally encounter each other to cause adverse reactions (e.g. fire, explosions, or a release of toxic or flammable gases or vapors). For example, flammables and oxidizers must be segregated from one another whenever possible, since flammable chemicals may easily ignite, and oxidizers act as fuel for fire.

Incompatible chemicals should be stored in separate cabinets, whenever possible. If incompatible chemicals must be stored in the same cabinet due to space limitations, adequate segregation (separate shelves) and secondary containment (e.g. plastic trays or Tupperware) must be used to prevent unplanned reactions. Secondary containment must be capable of holding any spilled material until it can be cleaned up and be constructed of a compatible material so that it is not degraded by the spilled material.

Particularly hazardous chemicals should be stored separately from any other chemicals by physical location or secondary containment and labelled as a "Designated Area". Contact RLSS for vinyl "Designated Area" labels or visit the RLSS website to print a "Designated Area" sign.
Consult the "Reference Guide to Chemical Storage and Segregation" on the RLSS website for further information. At a minimum, the following hazard classes should be segregated from one another:

- Corrosives (concentrated acids [≥ 1N] segregated from concentrated bases)
- Oxidizers
- Flammable Liquids
- Highly Toxic
- Highly Reactive

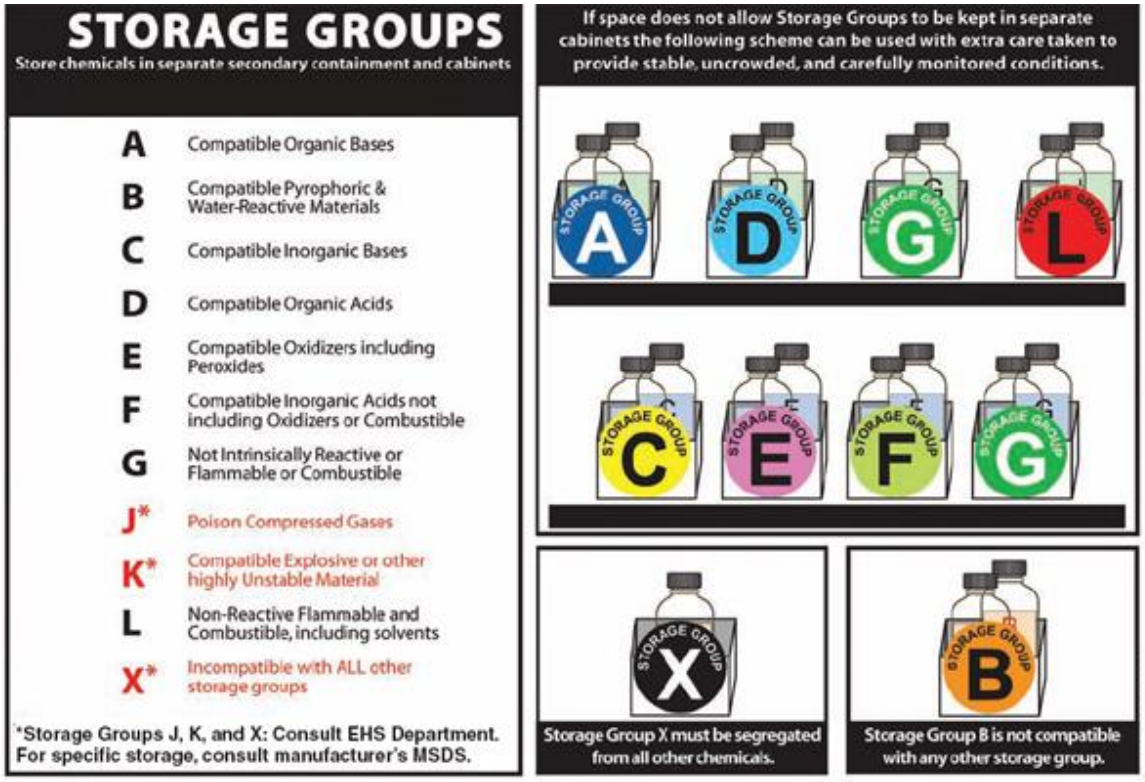


Figure from the National Research Council's "Prudent Practices in the Laboratory."

Keep in mind that one chemical may pose multiple hazards. When this occurs, a decision must be made on which storage area would be the most appropriate for each chemical. The following priorities should be followed when making these choices:

1. Flammability: The number one consideration when determining the storage location of chemicals in a laboratory is the flammability of the material. Flammable chemicals should be stored in a certified flammable cabinet.
2. Reactivity: Isolate any chemicals that tend to react violently with one another. Oxidizers should be isolated from flammables and combustibles in storage. Water-reactive materials should be isolated from water and water-containing chemicals.
3. Corrosivity: After flammability and isolation are considered, then consider the corrosive properties of the chemicals and store accordingly.
4. Toxicity: Finally, the toxicity of the material must be considered. Special attention should be given to particularly hazardous chemicals. In some cases, a chemical may need to be isolated within a storage area. For example, a chemical that is highly toxic and flammable may be locked away in the flammable storage cabinet to prevent accidental release.

4.8 Laboratory Security

It is critical that chemicals be secured to prevent theft from campus laboratories. Numerous federal agencies are involved in the maintenance of laboratory security, including the Drug Enforcement Agency, Federal Bureau of Investigations, and Department of Homeland Security.
Access to hazardous chemicals, including toxic and corrosive substances, should be restricted at all times. These materials must be stored in laboratories or storerooms that are kept locked when laboratory personnel are not present. Locked storage cabinets or other precautions are always recommended, and in some cases may be required in the case of unusually toxic or hazardous chemicals. Unusually toxic chemicals may include those that are associated with very low immediately dangerous to life or health (IDLH) conditions. For guidance on locked storage requirements, please contact RLSS. On termination or transfer of laboratory personnel, all related hazardous materials should be properly disposed of, or transferred to the laboratory supervisor or a designee.

It is each laboratory's responsibility to prevent and report any theft of chemicals from their laboratory. **Laboratories are encouraged to conduct a Security Value Assessment (SVA)**.
Aspects that should be covered in an SVA include:

- Existing threats, based on the history of the institution (e.g., theft of laboratory materials, sabotage, data security breaches, protests);
- The attractiveness of the institution as a target, and the potential impact of an incident;
- Chemicals, biological agents, radioactive materials, or other laboratory equipment or materials with dual-use potential
- Sensitive data or computerized systems;
- Animal care facilities;
- Infrastructure vulnerabilities (e.g., accessible power lines, poor lighting);
- Security systems in place (e.g., access control, cameras, intrusion detection);

- Access controls for laboratory personnel (e.g., background checks, authorization procedures, badges, key controls, escorted access);
- Institutional procedures and culture (e.g., tailgating, open laboratories, no questioning of visitors);
- Security plans in place; and
- Training and awareness of laboratory personnel.

Labs can increase their security by simply **keeping lab doors closed and locked when unoccupied**, maintaining a current and accurate chemical inventory, training personnel on security procedures, and controlling access to keys. Labs should report any suspicious activity to UAPD and RLSS as soon as possible.

4.9 Transport and Shipment of Hazardous Chemicals

The shipment of hazardous chemicals (i.e. consignment to a commercial carrier for transport to a destination) is different from the transport of hazardous chemicals (i.e. researchers transporting samples with hazardous chemicals between rooms, buildings and facilities). The shipment of hazardous chemicals should not be done by laboratory staff; it should be done via third-party or through Risk Management Services. If done via a third-party carrier by ground, air or water requires compliance with transportation codes/regulations (i.e. IATA-DGR, 49 CFR). The transport of hazardous chemicals out of commerce (for example, across campus from one laboratory to another) must follow certain safe transportation requirements but does not need to adhere to the full requirements of the 49 CFR. Contact RLSS to determine if your planned transport of chemicals is compliant with transportation practices, codes and regulations.

4.9.1 Hazardous Chemical Shipment

The shipment of hazardous chemicals requires adequate training on the 49 CFR and other applicable regulations (International Air Transport Association, IATA Dangerous Goods Regulations for air shipments). RMS provides this training for shipment of biological samples on dry ice and dry ice alone. RMS maintains staff with appropriate training to assist with hazardous chemical shipments for UA laboratories, including the completion of Department of Transportation (DOT) or IATA required paperwork. Contact RLSS if you believe a shipment of hazardous chemicals is required or if you have questions about hazardous material shipping requirements.

4.9.2 Hazardous Chemical Transport

Hazardous chemicals can be transported by hand, cart or university vehicle while not in commerce. Use secondary containment (e.g. a rubber pail) when transporting hazardous chemicals by hand. If more than two hazardous chemicals are being transported, and a vehicle is not required, a cart with side rails and secondary containment (e.g. deep plastic trays) should be used to contain any spill that may occur. The cart must be stable under the load and have wheels large enough to negotiate the travel surfaces (e.g. door thresholds) without tipping or stopping suddenly.

Use freight elevators to move hazardous chemicals whenever possible to avoid potential exposure to persons on passenger elevators. If use of a freight elevator is not possible and there is an elevated possibility of exposure to others, restrict access to passenger elevators while moving hazardous chemicals.

To transport compressed gas cylinders outside of the laboratory, secure the valve protection cap and utilize a suitable hand truck; only handle one gas cylinder manually at a time unless a manufacturer provided multi-rack (e.g. 25 scf medical oxygen cylinders) is used. The transport of bulk quantities of liquid nitrogen, dry-ice and other asphyxiates may require assistance from the UA Cryo staff for impromptu transport. Routine transport of compressed gas cylinders needs to be addressed in the LCHP for routine transport.

The transport of hazardous chemicals is should be performed only in a University-owned vehicle, provided the chemical is placed in tertiary level containment (e.g. in its original container, a sealed Ziploc bag and a sealed cardboard box with absorbent materials), blocked and braced so as not allow movement in any direction, and the transport is not in commerce. Hazardous chemicals should not be transported in privately-owned vehicles unless specifically authorized. Contact RLSS about conforming your transport needs with appropriate University policies and rules. **Hazardous chemicals cannot be transported using public (i.e. city bus, Sun Link) or public-like (i.e. CatTran) transportation.**

4.9.3 Field Use of Hazardous Chemicals

Hazardous chemicals may be transported to, and used in, field sites for UArizona research. The transport requirements mentioned above must be followed. In addition, field use of hazardous chemicals should minimize glassware and may not use open flames/heat sources. The following items must be available at a field site for the use of hazardous chemicals:

- First aid kit
- Portable eye wash (eye wash bottles)
- Adequate PPE (contact RLSS to determine appropriate PPE)
- Fire extinguisher (if flammable chemicals are in use)
- Chemical spill kit

Additional items may also be required depending on the RLSS assessment.

4.10 Hazardous Waste Disposal

The proper disposal of hazardous chemicals is necessary to prevent chemical exposure, unplanned reactions and to allow for cost-effective disposal. RMS is responsible for the removal of hazardous chemical waste from laboratories and for ensuring the proper transport, packaging and disposal of said waste; RLSS can only provide guidance but defers to RMS for all hazardous waste questions and collections. The AH/ASC is responsible for ensuring hazardous chemical waste is properly

consolidated/managed in the laboratory before it is collected. This responsibility includes proper segregation and identification of waste, contact RMS Hazardous Waste for assistance creating a waste segregation plan for your laboratory.

Waste pick-ups can be requested online, or by contacting RMS directly at hazmat@arizona.edu. RMS provides varying degrees of waste collection services for laboratories at satellite locations, depending on proximity to Tucson and availability of outside contractors. Contact your research laboratory facilitator or building manager for further information on waste disposal practices at your satellite location.

4.10.1 Waste Minimization

Waste minimization techniques should be practiced within every laboratory to allow UArizona to meet hazardous waste permit requirements and avoid paying unnecessary hazardous waste disposal costs. The most common and effective waste minimization technique is the reduction of source material (hazardous chemicals). Laboratories should only order the amount of chemicals required to complete an experiment or procedure and should be aware of special properties of chemicals that do not allow prolonged storage.

RMS manages the Pollution Prevention (P2) Program mandated by the Arizona Department of Environmental Quality (ADEQ). This program aids research laboratories in picking adequate substitutions, eliminating waste, providing advice on adequate purchasing decisions, and helping with spill and leak prevention. Contact RLSS for ideas about green substitutions. Various websites exist that suggest potential substitutes for harmful chemicals, such as greenchemistry.org. Some vendors also produce lists of potential substitutes, such as Fisher Scientific.

Some P2 good laboratory practices that may reduce chemical waste include:

- Review procedures and experiments beforehand.
- Reduce the total volumes of chemical used in experiments and utilize small scale procedures when possible.
- Use instrumental methods instead of wet chemical techniques whenever possible, as these generally require smaller quantities of chemicals.
- Distill and reuse chemical solvents, which not only reduces the amount of waste generated, but decreases the amount of chemicals that need to be ordered.

4.10.2 Drain Disposal

Very few hazardous chemicals are allowed to be disposed of in a sink that leads to publicly owned treatment works. When in doubt, do not drain dispose of a chemical. The following chemicals and chemical types are allowed down the drain when flushed with at least three times the disposed chemicals volume of water:

- Chlorine bleach solutions
- Ethanol, in amounts of 500mL or less
- Inorganic buffer solutions, not containing heavy metals or other prohibited contaminants
- Inorganic acid or base solutions, not containing heavy metals or other prohibited contaminants and only after neutralizing to a pH between 5.0 and 11.0

- Black and white photo developer that is not contaminated with even the smallest amount of photographic fixer, with a pH between 5.0 and 11.0

Under no circumstances should heavy metals, organic or halogenated solvents, or solutions with a pH outside of the 5.0 – 11.0 range be disposed of down the sink. Solutions may be neutralized to be brought within this range before drain disposal if they do not contain any other hazardous materials. Contact UArizona Risk Management Services department for more information about drain disposals, as permitting issues and local governance may have additional restrictions and requirements.

4.9.3 Hazardous Waste Storage and Segregation

RMS provides waste buckets to all laboratories. Liquid waste should be collected in a 3.5-gallon plastic bucket and must be labeled with the yellow Hazmat label, as provided by RMS. The inlet hole of the lid should be aligned so it is 90° from the handle, and the lid should be completely affixed on the bucket using a mallet or hammer. These waste containers may be recycled through RMS. In order to have the bucket return, you must write your building name, room number and name on the bucket, that same bucket will be returned to you once/if successfully emptied. It is recommended that laboratories keep a two-month supply of waste buckets to ensure the laboratory has waste containers while RMS empties the full containers removed from the laboratory.

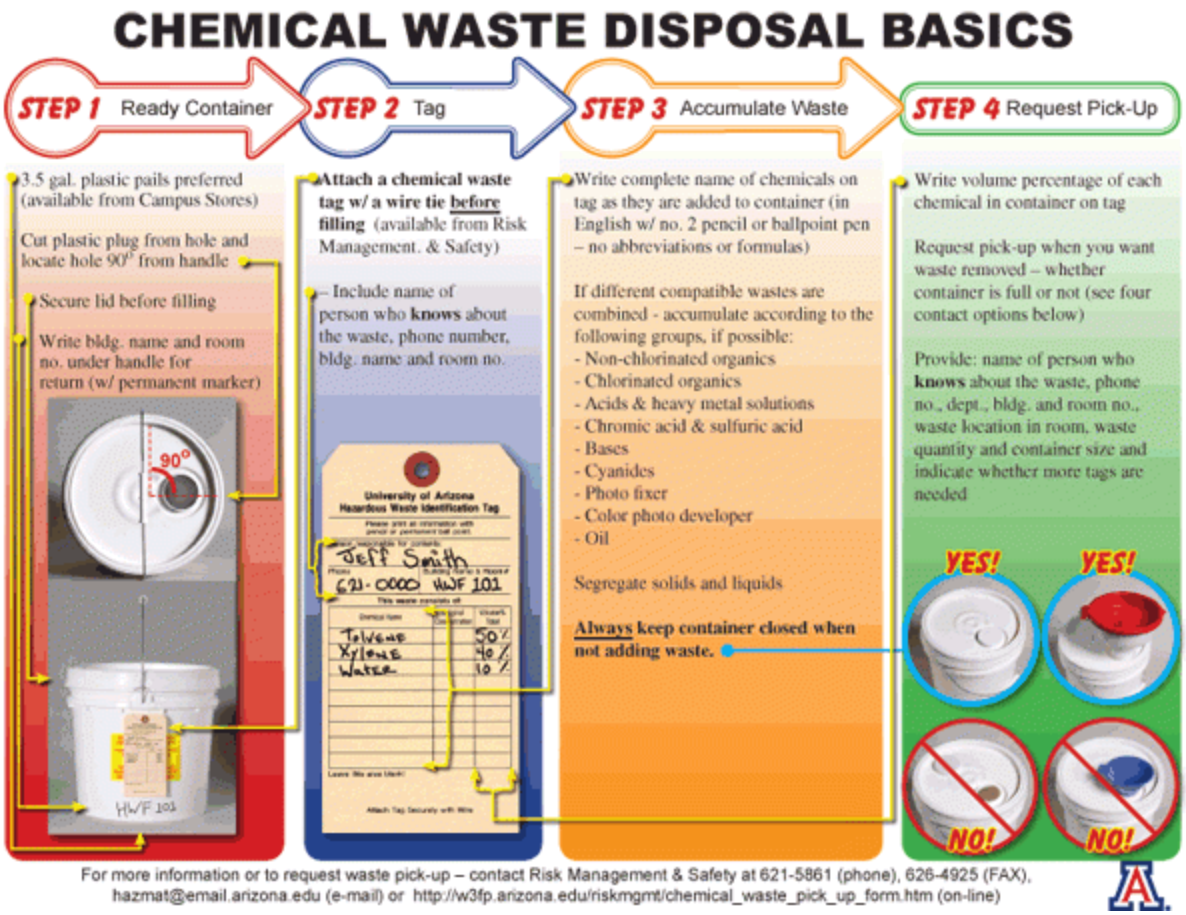
If using a waste container other than the 3.5-gallon HDPE plastic waste buckets, the container must be compatible with the chemical waste. **The use of glass bottles for hazardous waste is strongly discouraged and their routine use must be approved/coordinated with the Hazardous Waste Supervisor at Risk Management Services**. The original label on the container must be fully defaced and the container should be decontaminated/rinsed prior to use. Containers of hazardous chemical waste must be completely closed/covered at all times, except when adding waste. If using an approved ECO Funnel to collect hazardous waste in the waste buckets, this funnel must be closed when not in immediate use. RMS may also approve the use of waste drums for laboratories generating large volume of waste; contact RMS for questions regarding the use of waste drums.

All waste containers in use must have an RMS Waste Identification Tag affixed to them, which must include the information listed below. As each chemical is added to a waste container, the complete chemical name should be added to the Waste Identification Tag.

- Name (person most responsible for the waste in the container)
- Phone number
- Building name and laboratory number
- Full chemical name of waste(s)
- Estimated percentages of each chemical’s total volume in the waste container

Solid and liquid waste must be segregated, with solid waste disposed of in taped shut double plastic bags and tied or otherwise closed to ensure leakage is prevented. Liquid waste should be segregated into the following compatibility groups, using different containers for each group:

- Non-halogenated organics, including organic acids (e.g. acetone)
- Halogenated organics (e.g. chloroform, dichloromethane)
- Inorganic acids and heavy metal solutions
- Inorganic bases
- Cyanides
- Photo fixer



RMS Hazardous Waste Disposal Basics.

4.10.4 Hazardous Waste Collection

Submit a waste pick-up request to RMS when chemical waste containers are ¾ full. Collection requests can be submitted by email (hazmat@email.arizona.edu), phone (621-5861), fax (626-4925), or online at http://risk.arizona.edu/chemical-waste-pick-form. Whatever method of request is used, the laboratory worker requesting pick-up must provide the following information:

- Name of a person who knows about the waste
- Phone number of a knowledgeable individual
- Building name and room number where the waste is stored
- Principal Investigator
- Specific location of waste in the room
- Number of containers and size of each container ready for collection

- Request for tags and wires, if needed

RMS will only collect waste if a request has been made and all of the information above has been provided. A regular pick-up schedule exists for the collection of hazardous chemical waste across campus based on location. For laboratories in the Chemistry Department, requests must be received by Thursday night of the week of pick-up. For laboratories on the Quadrant Schedule, requests must be received by the Wednesday before the scheduled pick-up day. For more information on chemical waste disposal, contact the Hazardous Waste Supervisor at RMS.

For laboratories that have closed and require a cleanout, please follow these steps:

1. Put all solid chemicals with original labels that contain the original chemicals into boxes. Make sure the boxes are no larger than 12x12x12 and less than 50 lbs.
2. Liquid chemicals in their original containers must be consolidated into one area within the lab; do not box liquid chemicals. If the liquid container has the original label and it remains accurate and legible, a waste tag is not required. All other containers require a waste tag.
3. Chemical mixtures must be tagged with a chemical tag, and the contents of the mixture stated on each tag. Unknown chemicals should be tagged with a chemical tag and "unknown" be listed for the contents.

Note: Lab cleanouts are scheduled events. A pickup for a lab cleanout can take anywhere from 2 days to 3 weeks depending on the volume at the hazardous waste facility.

4.10.5 Unlicensed Radioactive Material Disposal

There are some radioactive compounds that do not require a radioactive materials license or registration into UArizona Radiation Safety Program for laboratories to possess. These compounds are categorized as hazardous chemicals, and the use and storage of them falls under the Laboratory Chemical Safety Program. Examples of unlicensed radioactive materials include:

- Uranyl acetate
- Uranyl nitrate
- Uranyl fluoride
- Thorium acetate
- Thorium nitrate

Though the possession of these compounds is not regulated by the Radiation Safety Program, they **must be disposed of as radioactive waste through RLSS, not as hazardous chemical waste through RMS**. To request collection of an unlicensed radioactive material, complete an online radioactive waste pickup request on the RLSS website or by contacting RLSS at rlss-rad-support@arizona.edu.

4.10.6 Contaminated Sharp, Glass, & "Sharp-Like" Wastes

Sometimes sharp waste (i.e. syringe needle, razor blade), sharp-like waste (i.e. pipette tips ≤1 mL) and glass waste (i.e. test tubes, broken glass) becomes contaminated with hazardous chemicals and must be prepared for collection by RMS as hazardous waste. Ensure that these wastes are promptly

packaged in accordance with RMS rules (i.e. use of a plastic or cardboard barrier container); contact the RMS hazardous waste if you have any questions. Failure to immediately place sharp, sharp-like and glass wastes into appropriate collection containers has caused injury amongst researchers and support staff.

4.10.7 Empty Primary and Secondary Chemical Containers

Primary and secondary/temporary chemical containers may be disposed of as regular waste as long as the following conditions are met:

- The container is suitable for the physical hazards of the container. Glass containers must be within a barrier container (bag lined corrugated cardboard box, rigid plastic container).
- Hazard communication labelling/pictograms have been defaced.
- The hazardous contents have been removed to trace amounts (remaining chemicals cannot be reasonably/safely removed).

Waste containers, whether empty or full, must never be left in pedestrian areas of buildings, such as hallways, offices, etc.

5. Maintenance of Equipment

All laboratory safety equipment must be inspected and tested on a regular basis to ensure their proper function. If the fume hood, fume hood alarm, emergency eyewash, safety shower, and fire extinguisher in your area have not been inspected in accordance with the schedules mentioned below, either call Facilities Management (FM) at 621-3000 (Tucson campus) and submit a work request or contact your facility manager. If an AH or ASC is brought aware of a piece of equipment that is past due for its inspection, they must contact FM, or the facility manager and organize a time for the inspection/certification.

Laboratories in satellite locations may be required to perform their own inspections, according to appropriate standards and guidelines, or rely on an outside contractor for these services. For further information on protective equipment inspection responsibilities at your satellite location, contact your building or facility manager.

RLSS will verify adequate airflow for all laboratory local contaminant exhaust systems during routine inspections;

- Snorkels/elephant trunks
- Gas Cabinets (these are certified annually by FM)
- Other exhausted devices and ventilation, as required

5.1 Chemical Fume Hoods

It is up to the AH and/or ASC to ensure their fume hoods contain a viable workspace: this means they are not overcrowded, and their sash is pulled down to the appropriate level, especially when in use. Chemical fume hoods are tested and certified by FM on the main campus and contractors at some satellite locations annually. After a fume hood passes the testing procedures, it will be posted with an inspection label indicating when the fume hood was last inspected, when it is due for its next inspection, and the maximum sash open position.

An uncertified chemical fume hood should never be used to control hazardous chemical exposures. If it is absolutely necessary that certain functions involving hazardous chemicals be performed in an uncertified fume hood before it can be recertified, contact RLSS. RLSS can perform face velocity measurements to determine if the fume hood is appropriate for temporary hazardous chemical use before certification.

5.2 Decontamination Devices

Emergency safety showers, eye wash stations and dousing stations are inspected by Facilities Management (or third-party vendors for satellite locations) quarterly. At the time of inspection, the decontamination device will receive an inspection tag, indicating when it was last inspected and by whom.
All eyewash and dousing stations should be flushed by laboratory personnel on a weekly basis. Detachable faucet-mounted eyewashes are not inspected by Facilities Management. The AH/ASC must ensure these devices are inspected by laboratory workers quarterly; further

information (i.e. inspection checklist and the required inspection tag) are available on the RLSS website. The AH/ASC is also responsible for ensuring that access to decontamination/wash devices is not blocked by boxes, equipment or other items. Safety showers must have a clearance of 16 inches on every side. **Dousing and eye wash stations require 6 inches of clearance on every side**.

5.3 Fire Extinguishers

Facilities Management (or vendors for satellite locations) performs annual inspections of all registered portable and non-portable fire extinguishers in laboratories. Unregistered firefighting equipment should be maintained in accordance with their manufacturer's requirements/recommendations. **A physical check of fire extinguishers should be performed monthly by a member of the laboratory or building staff**.

Either all members of the laboratory chemical safety approval need to complete online "Fire Safety Awareness" training, or at least one person working in the laboratory must complete the "Fighting Fires with Portable Fire Extinguishers" training provided by Risk Management Services (RMS) and document laboratory firefighting and safety practices for other lab members during their Laboratory Specific Training. For further information about fire extinguishers, and to register for the fire extinguisher training, contact RMS.

5.4 Other Equipment

Gas Cabinets are inspected by RLSS during routine inspections but are certified annual by FM to ensure adequate ventilation. Certification labels will be placed on gas cabinets that pass quantitative assessment. **Contact RLSS prior to the order of any new gas cabinets, or gas cabinets that have been significantly modified since their last inspection**. Contact FM for the installation of new approved cabinets, and for any repairs or modifications on existing cabinets.
Other equipment and devices, including medical devices (e.g. isoflurane vaporizers, gas monitors, ophthalmology excimer lasers, etc.) are not certified by FM or RLSS. It is the AH/ASC's responsibility to make sure these devices are maintained and used according to manufacturer recommendations, and that all of their workers are trained upon the proper/expected use of these devices.

Isoflurane effluent must either be evacuated (i.e. approved vacuum line, fume hood, etc.) or scrubbed (i.e. columns, cartridges). Isoflurane scrubber cartridges must be used in accordance with the manufacturer's recommendations and properly positioned/oriented so as not to obstruct gas flow. Typically, isoflurane scrubbers must be weighed prior to use and replaced once a specified weight of scrubbed gas effluent has been captured. Be sure to legibly document the weight of scrubber cartridges so all isoflurane users are aware of the proper conditions for replacement. Contact RLSS to measure the efficacy of isoflurane gas scrubbing/evacuation, or to assess for delivery system leakage (e.g. leakage of lines, seals, gaskets, delivery nose-cone).

6. Particularly Hazardous Chemicals

Additional safety-related requirements apply to the storage, use and generation of particularly hazardous chemicals. Each chemical in the RLSS online User Dashboard Inventory & SDS interface is classified as a non-hazardous chemical, a hazardous chemical, or a particularly hazardous chemical. When an Approval adds a chemical to their inventory using the RLSS User Dashboard, that classification will automatically appear, informing the Approval of which chemical(s) require additional precautions.

6.1 Designated Area Signs

All storage and work with particularly hazardous chemicals must be performed in a designated area. A designated area may encompass the entire laboratory, an area of a laboratory, or a device such as a chemical fume hood or storage cabinet. This must be communicated to workers through proper labeling, Laboratory Specific Training and the Laboratory Chemical Hygiene Plan. The following guidelines should be followed regarding designated areas:

- The designated area should be the smallest practical area for the application so that the scope of any potential accident is limited.
- Designated areas must be posted with the RLSS "Designated Area" label to ensure all laboratory workers are aware of the increased hazards.
- Designated areas should have restricted access and should be segregated from other chemicals by distinct physical location or secondary containment.
- Benches or other work surfaces that may become contaminated by routine use of particularly hazardous chemicals should be fitted with disposable and removable coverings.

For more detailed information on the creation of a designated area and the required labeling, or to obtain "Designated Area" labels, contact RLSS at 626-6850 or print them from the RLSS website.

6.2 Containment Devices

Particularly hazardous chemical use almost universally requires the use of a containment device, such as a chemical fume hood, appropriate biosafety cabinet (i.e. BSC II Type B2), glove box, etc. Work with volatile particularly hazardous chemicals, or their aerosols/mists/dusts, must be within a chemical fume hood or other containment/evacuation/purification device. Some chemicals require specific containment devices, which will be detailed in the chemical's (M)SDS. **Any work with particularly hazardous chemicals that must be performed outside of an appropriate containment device may be assessed by RLSS to ensure that laboratory workers are not overexposed.**

6.3 Safe Removal of Contaminated Waste

Some particularly hazardous chemicals may require special procedures (i.e. RCRA wastes, pharmaceutical wastes) for the disposal of waste and contaminated materials, such as PPE. Additional procedures may include warning labels for waste containers and waste segregation. When in doubt, consult the chemical's (M)SDS or contact RMS hazardous waste for proper disposal procedures. If special disposal procedures are required for a particularly hazardous

chemical, these procedures must be included in the laboratory's LCHP, and everyone working in the laboratory must be trained upon the proper procedures during their Laboratory Specific Training.

6.4 Decontamination Procedures

Some particularly hazardous chemicals may require special procedures for decontamination or deactivation, such as diaminobenzidine waste or ethidium bromide. (M)SDSs should be reviewed to identify if special decontamination procedures are required for equipment, glassware, clothing and shoes, workspaces, or certain areas of the body (e.g. hands and harms). Procedures must be included in the LCHP and all laboratory workers working with these chemicals must be properly trained.

7. Chemicals and Procedures Requiring Prior Approval

Prior approval from RLSS is required for the use of certain hazardous chemicals or the performance of certain activities involving hazardous chemicals.

7.1 Hazardous Gases

Certain gases require prior approval by RLSS before they can be ordered. **UA Cryo will not fulfill any hazardous gas orders without RLSS authorization**. Do not attempt to order any of the gases listed below, or those listed in Appendix B-14, "Use of Hazardous Gases SOP" from outside UA Cryo (i.e. calibration gas from scientific vendor) without RLSS authorization.
These gases are more stringently controlled due to their toxicity, corrosivity, flammability, and/or possibility for abuse. Because of the extreme hazards involved with these gases, RLSS must ensure the proper control measures will be implemented when storing and using the gas before the gas is ordered and delivered to the laboratory. Common gases currently requiring prior approval in their liquefied or compressed form are listed below. **A full list is located in the "Use of Hazardous Gases SOP" in Appendix B.**

- carbon monoxide
- ammonia
- nitrogen dioxide
- nitric oxide
- 1,3-butadiene
- silane
- fluorine
- hydrogen selenide
- chlorine
- hydrogen fluoride
- hydrogen sulfide
- sulfur dioxide
- silicon tetrafluoride
- hydrogen chloride
- vinyl chloride
- ethylene oxide
- phosphine
- deuterium chloride

To request a hazardous gas order, complete and submit the Hazardous Gas Order Request on the RLSS website. RLSS will investigate all requests and either approve, conditionally approve, or disapprove of them, based on the laboratory's compliance with the requirements detailed in appendix B of this plan, see "Use of Hazardous Gases SOP." RLSS may request the assistance of technical experts in the determination of hazards (i.e. Fire Marshal, specialty gas company, safety or process experts) related to the use and possession of hazardous gases.

Continuing RLSS assessment and approval is required for all previously authorized orders (i.e. replacement or backup cylinder) of a hazardous gas. These assessments verify that proper control measures for the hazardous gas use and storage are being maintained prior to order approval or fulfillment.

7.2 DEA Regulated Controlled Substances

Controlled substances are regulated by the 21 CFR Part 1300 via the U.S. Drug Enforcement Administration (DEA). The DEA allows for the purchase and possession of controlled substances for research use. Research use of a controlled substance must be under the oversight of an

individual registered with the DEA (aka, "Registrant"); any person handling a registrant's controlled substances must be documented as an "agent" of the registrant. Contact RLSS for onsite assistance with the DEA registration application process, form templates, fee exemption information, security/diversion consultation, and inspection criteria.

See Appendix B for DEA Controlled Substances Information: application, classifications, recordkeeping, storage and security, disposal, etc.

7.3 ATF Regulated Explosive Materials

7.3.1 Explosive Materials at UArizona

RLSS considers Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF)-regulated explosives to be hazardous chemicals; therefore, their use and storage falls under the purview of this UCHP. Research use of normally licensed explosive materials at the University of Arizona has been exempted from licensure, but not from any of the security requirements found in 27 CFR Part 555 Subpart K. Contact RLSS if you need a copy of this exemption for ordering purposes. It is RLSS's objective to maintain a record of all licensable explosive material use and storage, as well as to ensure explosives purchased and used under the University exemption are stored properly.
UA researchers who obtain ATF-regulated explosives must be appropriately trained and follow the safe storage requirements for explosives (27 CFR Part 555 Subpart K). Students may only handle explosives if a trained worker is present for oversight at all times, and additional restrictions exist for minors participating in explosives use/research.

In addition, a laboratory's use and/or storage of ATF-regulated explosive materials requires exception from the Arizona Revised Statutes (ARS)§ 12-781 by the University of Arizona Police Department via conforming with the requirements of the University of Arizona Weapons on Campus Policy. Contact RLSS for assistance with the licensure process required for obtaining and using ATF-regulated explosives, or for assistance with the exception process from the ARS§ 12-781. The use of some explosive materials may also fall under the purview of the Export Control Officer or the Fire Marshal.

7.3.2 Classes of Explosive Materials

For the purposes of storage, ATF-regulated explosive materials are placed into three classes. Certain explosives (e.g. smokeless powder, insensitive ammunition compounds, flash powder, etc.) are not regulated by ATF but are considered hazardous chemicals by RLSS. The three classes of explosive materials classified by ATF are listed below.

- High explosives: can be caused to detonate by means of a blasting agent when unconfined (e.g. dynamite, flash powders, bulk salutes)
- Low explosives: can be caused to deflagrate (i.e. burn or cause burn with intense heat and light) when confined (e.g. black powder, safety fuses, igniters)
- Blasting agents: include ammonium nitrate-fuel oil and certain water-gels

7.3.3 Safe Storage of Explosive Materials

ATF-regulated explosive materials must be securely stored in a matter compliant with the ATF regulations (27 CFR 555.207 – 555.211), using appropriate storage magazines and locks. Magazines are storage containers specifically designed and constructed to store explosive materials. However, different classes of explosive materials require different specific magazine types. The following chart explains the types of magazines and their requirements.

Magazine Type	Description	Requirements	Explosive Material Class(es)
Type 1	Permanent (e.g. building, igloo, tunnel, dugout, etc.)	Bullet-resistant, fire-resistant, weather-resistant, theft-resistant, ventilated	High Explosives Low Explosives Blasting Agents
Type 2	Mobile and portable, indoor and outdoor (e.g. box, trailer, semitrailer, etc.)	Outdoor: bullet-resistant, fire-resistant, weather-resistant, theft-resistant, ventilated, not directly on ground, slope away for drainage Indoor: fire-resistant, theft-resistant, not in residence or dwelling	High Explosives (≤ 50lbs) Low Explosives Blasting Agents
Type 3	Temporary portable outdoor (e.g. day-box)	Must be attended at all times, fire-resistant, theft-resistant	High Explosives Low Explosives Blasting Agents
Type 4	Outdoor and indoor (e.g. building, igloo, trailer, semitrailer, etc.)	Outdoor: fire-resistant, weather-resistant, theft-resistant Indoor: theft-resistant	Low Explosives (≤ 50lbs indoors) Blasting Agents
Type 5	Outdoor and indoor (e.g. building, igloo, tunnel, dugout, bin, box, trailer, semitrailer, etc.)	Outdoor: weather-resistant, theft-resistant Indoor: theft-resistant	Blasting Agents (≤ 50lbs)

For the majority of situations, researchers should rely on professional explosives magazine manufacturers to comply with ATF standards. See the "Common Purchase List" on the RLSS website for a list of common storage providers. If you do not wish to utilize one of these resources, contact RLSS for further guidance on the construction of explosives storage magazines.
If indoor magazines are used, the total amount of explosives material in that building cannot exceed 50 pounds. Multiple magazines may be present in the same building, but the sum quantities of explosive materials in all magazines must be less than or equal to 50 pounds. Containers of explosive materials must be stored so their required markings are visible and so the amount of explosive materials can be easily counted. Wording on what markings must be found on explosive material containers can be found in ATF regulations. Contact RLSS for guidance about what magazines or markings are required.

All tools to be used inside a magazine or with explosive materials must be non-sparking. Smoking, matches, open flames and spark-producing devices are not permitted in any magazine, within 50 feet of any outdoor magazine or within any room containing an indoor magazine. Magazines must be kept clean, dry and free of paper, empty packages, containers and general clutter; the area

surrounding magazines must also be kept clean and free of unnecessary items for at least 25 feet in all directions.

Any person storing explosive materials must inspect their magazines at least once every seven days. This inspection does not need to be a full inventory but must be able to determine whether there has been unauthorized entry or attempted entry into the magazines, or removal of the contents of the magazines.

7.4 Chemical Facility Anti-Terrorism Standards (CFATS)

The Department of Homeland Security maintains a list of chemicals and compounds considered to be "Chemicals of Interest" (COI). The full list is found in Appendix A of the 6 CFR Part 27; a link for this list is on the RLSS website. AHs within a building/facility whose cumulative possession of a COI exceeds the listed threshold amount may need to comply with additional security, documentation, and reporting requirements. RLSS will inform AHs about any CFATS requirements that may apply to their laboratory chemicals in use/possession.

7.5 Biological Toxins

As per the Biosafety Reference Guide, the use of biological toxins in a UA laboratory requires registration into both the Biosafety Program and the Laboratory Chemical Safety Program. The signs and symptoms of exposure to the biological toxin, as well as the need to report them to the AH or ASC, must be clearly communicated within the laboratory's Biosafety Standard Operating Procedures, as per the University of Arizona's Biosafety Reference Guide. Additional compliance parameters for the use and storage of biological toxins in a laboratory should be discussed with RLSS.

7.5.1 Staphylococcal Enterotoxin Exposure Signs & Symptoms

Staphylococcal enterotoxin exposure signs and symptoms differ upon route of exposure. Oral exposure patients typically present a rapid onset of nausea, vomiting and diarrhea for duration of illness that is less than 24 hours. Inhalation exposure patients typically present sudden fever, headache, chills, myalgia and non-productive cough for duration of illness lasting up to 2 weeks. Prior to any planned use/possession of staphylococcal enterotoxin, contact UA Occupational Health for clinical advice/services regarding your potential exposure.

7.6 Minors in the Laboratory

Minors (i.e. students, volunteers or compensated workers) may have access to laboratories for research and/or educational purposes, at the discretion of the AH. All youth programs and their activities within lab spaces must be registered with the Office of Youth Safety. The laboratories that a minor can enter are dictated by their objectives and employment status, due to Department of Labor regulations.

7.6.1 Compensated or Volunteer Minors

Minors that are financially compensated for their work, as well as uncompensated volunteers whose work is directed purely toward the goals and objectives of the laboratory (rather than working as part of a recognized educational program), are considered to be employees. At minimum, these individuals must be registered Designated Campus Colleagues (DCC's) by a University Department, College or Organization. These minors must adhere to the Department of Labor's Occupation Standards limitations by age group (14 & 15 year olds or 16 & 17 year olds). A 16 or 17-year old minor employed in a laboratory as a volunteer or compensated worker must be registered by the host UA department as a Designated Campus Colleague (DCC), obtain a NetID and complete both the online General Laboratory Chemical Safety Training and Laboratory-Specific Training. 16 and 17-year old laboratory workers may only observe work with particularly hazardous chemicals or hazardous gases. A 14 or 15-year old worker may not be employed in hazardous chemical laboratory workplace.

7.6.2 Minors in a Laboratory under an Approved Education Program

Unlike volunteers and compensated workers, a student participating in experiments or processes in a laboratory as part of an educational program that is recognized and approved by the laboratory's PI, Department Head, Dean and UA Office of Youth Safety, is working for the betterment of him/herself, not the laboratory. In this case, the Department of Labor standards do not apply. Instead, a minor classified as a student is regulated by the same Laboratory Chemical Safety Program rules as for students in a teaching laboratory. These minors may participate in supervised appropriate/relevant experiments that fulfill the educational program's objectives within a laboratory environment. However, they must receive documented laboratory-specific training from the hosting PI(s), ASC(s), or laboratory supervisor(s) and must be supervised by a trained adult employee at all times. RLSS will require the following documentation prior to authorizing a minor's presence within a laboratory workplace:

- Acceptance of the minor's academic program from Office of Youth Safety.
- Letter from minor's teacher or school administrator that explains the academic program and its laboratory learning objective(s).
- Letter from either the hosting AH, Department Head, or Dean that accepts the student as an intern to complete the program's academic objective(s). See Appendix G mentioned below for a suitable form.
- Completion of all forms found within the appendices of the "Interactions with Non-Enrolled Minors Policy" found on the Human Resources website.
    - Appendix A: Administrative Approval of One-on-One interaction with a Minor
    - Appendix B: Parental/Legal Guardian Disclosure of One-on-One Interaction with a Minor
    - Appendix C: Image Release (only if photos will be taken of the minor)
    - Appendix D: Behavioral Expectations for Minors
    - Appendix E: Behavioral Expectations for Authorized Adults (for all supervising the minor)
    - Appendix F: Program Participant Information
    - Appendix G: Program Information Form

7.7 Export Control

Some chemicals, data, technologies, and other laboratory-related items could be controlled from travel (i.e. presented at a conference) and export (i.e. provided to a foreign national). UArizona has an Export Control Office that provides information and services to laboratories regarding controlled information, technical data, technologies, software and hardware for reasons of national security. The major export control regulations include:

- Export Administration Regulations (EAR): 15 CFR 730-774
- International Traffic in Arms Regulations (ITAR): 22 CFR 120-130
- Office of Foreign Assets Control Regulations (OFAC): 31 CFR 500

Experiments involving export-controlled materials and/or technology have specific regulatory requirements, including the development of a Technology Control Plan, additional training, etc. Contact the Export Control Office at 626-2437 if you plan to:

- Employ a non-U.S. citizen to work on an export-controlled research project;
- Collaborate with a foreign person or government (e.g. sharing documents, emails);
- Travel, ship or transfer export-controlled items (e.g. laptop, data/technology, blueprints, and presentations) to certain countries (i.e. Cuba, Syria, Iran, North Korea or Sudan); or
- Conduct business (e.g. money transactions, exchanging goods or services) with certain foreign nationals or entities (i.e. Cuba, Syria, Iran, North Korea or Sudan).

7.8 Special Chemical Concerns

7.8.1 Nanomaterials

Nanomaterials range from 1-100 nanometers in size and can either be naturally occurring (e.g. volcanic ash, diesel combustion by-product) or manufactured. They have unique physical and chemical properties and are still being investigated for their health effects upon those exposed to them. Nanomaterials can come in many forms: powders, aerosols, colloids, liquid suspensions, etc. Common nanomaterials in use at UArizona include carbon nanotubes, metal oxide nanoparticles, quantum dots, and more. Due to the uncertain health and physical hazards nanomaterials pose, RLSS must be contacted prior to the use of any nanomaterials to conduct a hazard assessment, which will determine on a case-by-case basis the proper controls (engineering, administrative, and person protective equipment) required to prevent exposure to both nanomaterial users and those around them.

7.8.2 Isoflurane & Waste Anesthetic Gases

Isoflurane is a halogenated hydrocarbon commonly used as an anesthetic gas. It has been identified as an irritant to the eyes, skin, and respiratory tract of exposed workers. Some evidence suggests that isoflurane exposure may act as a developmental and reproductive toxin. While there is no OSHA permissible exposure limit (PEL) for isoflurane, nor common halogenated anesthetic gases, best practices stipulate that exposure should be maintained at the lowest achievable limit. Isoflurane, and other anesthetic gas exposures can be eliminated and/or reduced by the using the identified best practices on the RLSS website. Contact RLSS with any concerns regarding isoflurane, or other anesthetic gases, for a hazard assessment and determination of the proper controls necessary to mitigate exposure.

7.8.3 Additive Manufacturing/3D Printing

Additive manufacturing, sometimes called 3D printing, is a process used to build geometry out of a raw material without the constraints of traditional tooling. Generally, software is used to "slice" a 3D model into thin layers which are built successively onto a build platform. Multiple additive technologies exist, each with the ability to produce a variety of materials and geometries. These technologies, however, pose unique and potentially serious risks to the users and buildings. They may produce nanomaterials, hazardous gases or vapors, and potentially utilize extremely flammable or explosive materials. RLSS and RMS must be consulted **PRIOR** to the use of any plastic-type 3D printers, and **PRIOR** to the purchase or use of metal additive manufacturing equipment.

7.8.4 Cryogenic Storage Facilities

Cryogenic liquids are liquefied gases that are kept in their liquid state at very low temperatures. Cryogenic liquids have boiling points below -150°C (- 238°F). Inert cryogenic liquids do not undergo chemical reactions under normal conditions and are considered to be nontoxic. The gases they give off are colorless, odorless and tasteless which can make a leak or exposure difficult to detect. Their low temperatures can cause cryogenic burns on contact with skin and embrittle materials leading to structural damage. More significantly, the high expansion ratio of these liquids increases the potential to create dangerous oxygen deficient atmospheres leading to the possibility of asphyxiation of individuals working in or entering facilities. Without a proper hazard analysis followed by implementation of the necessary controls, university students and staff may be at risk for an adverse event. RLSS and RMS staff should always be consulted regarding the proper control measures required dependent upon the amount and type of cryogen as well as the size of the laboratory and ventilation available in the room. Dependent upon the potential to creation oxygen deficiency, oxygen deficiency alarms and/or monitoring systems may be required in addition to written safe operating procedures and appropriate personal protective equipment. Please see Appendix B-17 for further information.

7.8.5 Other Chemicals of Concern

The following list is not comprehensive but are chemicals which require additional control measures. In order to help protect worker health and safety, RLSS has SOPs for these chemicals and more; please contact RLSS for assistance. This library of SOPs is updated regularly; please contact RLSS if you are working with these chemicals or other chemicals of concern to create an SOP.

- Aqua regia
- Hydrofluoric acid
- Perchloric acid
- Picric acid
- Piranha and/or Base-piranha
- Osmium tetroxide

8. Emergency Response

IN CASE OF AN EMERGENCY:
CALL 911 to contact local Emergency Response

The previous sections of this document have focused on preventing hazardous chemical related "events" (i.e. spills, exposures and injuries) in the laboratory. Rarely, laboratory hazardous chemical related events may rise to the level of being considered "emergencies", where considerable risk to life, environment, or property exist and response from multiple University and non-University assets are required to save life, protect property and safeguard the environment.

In the case of an emergency on the main UA campus, call 911. If you reach the Tucson Police Department (TPD), ask to be transferred to the University of Arizona Police Department (UAPD) for an emergency situation on campus. Emergency response at satellite locations is provided by local law departments and emergency responders. Therefore, in an emergency, satellite locations should call 911, take care of the situation with the emergency responders and then report the incident to RMS and RLSS as soon as is practical.

8.1 Emergency Preparedness

Emergencies can happen at any time, without any warning, taking the form of injuries, fires and explosions, spills and exposures, and natural disasters. If the proper planning is carried out beforehand, laboratory members will be able to respond to such emergencies appropriately, which may help minimize damage and save lives.
To be generally prepared for an emergency, all laboratory workers should know the location of the emergency equipment in the laboratory area (e.g. safety shower and eyewash, fire extinguisher, fire alarm, telephone, spill kit, first aid kit, etc.), as well as how to use them. This information should be detailed in the Laboratory Chemical Hygiene Plan (LCHP) and covered in the laboratory-specific training documented by the approval's AH/ASC. Access to all safety and emergency equipment (e.g. emergency shower and eyewash, fire extinguishers, fume hoods, etc.), exits, and laboratory or building egress paths, must remain unobstructed at all times.

8.1.1 Evacuation Map

Every workspace is required to post an evacuation map in a visible location by the fire code, and to train workers on the proper procedures in case of an evacuation. Consider regular fire drills to allow for laboratory members to practice the procedures of leaving a laboratory and meeting at a pre-determined, safe location. Maps of all laboratory spaces and building floorplans can be found on the Planning, Design & Construction website to create an evacuation map.

8.1.2 Fire Extinguisher

Proper maintenance of a fire extinguisher and the knowledge of its use are necessary to be fully prepared for a fire-related emergency. An appropriate certified fire extinguisher must be present within 75 feet of every workplace that uses/possesses flammable chemicals. The most common type of fire extinguisher found in our laboratories is the ABC type of fire extinguisher, which are able to extinguish fires caused by normal combustible materials like paper or cardboard, flammable liquids, and electronic devices.

Class D fire extinguishers OR dry sand may also be required in a laboratory if combustible metals (e.g. magnesium, potassium and sodium) and/or pyrophoric organometallic reagents (e.g. alkyllithiums, Grignards and diethylzinc) are stored or used in the laboratory.

A fire alarm and telephone for emergency use must also be nearby (within 50 feet).

8.1.3 First Aid Kit

Every laboratory is required to have an ANSI-compliant first aid kit, with its location known to every laboratory worker. An AH's first aid kit may be shared between any of their contiguous laboratories (i.e. separated by a single door) or collocated AH's. These kits may be home-made or purchased, as long as they adhere to all of the requirements.

8.1.4 Chemical Spill Kit

A chemical spill kit is also required to be present in every laboratory to prepare for minor chemical spills. As with first aid kits, an AH's chemical spill kit may be shared between any of their contiguous laboratories (i.e. separated by a single door). In case of a minor chemical spill, every laboratory needs to have the following items, with the location and proper use of each item known to every laboratory member.

- Absorbent materials, such as pillows, pads, paper-towels, etc.
- Neutralizing materials (sodium bicarbonate for most acids and citric acid/vinegar for most bases)
- PPE (gloves, laboratory coat and splash goggles)
- Containment/waste packaging supplies (bucket, box, garbage bags)
- A dustpan and broom for select solids
    - Toxic solids should not be swept, as they may pose an inhalation risk to the worker

Note: **Consult with RLSS for the best neutralizer for your acids/bases and absorbent materials; some materials may react exothermically with the spilled chemical and/or generate toxic byproducts.**

Components of a chemical spill kit must be consolidated within a portable kit, whenever possible. If components must be kept outside of the consolidated kit, their location must be detailed in written instructions inside or outside of the kit container and in the LCHP; this must also be reviewed during Lab Specific Training. See the "Reference Guide to First Aid and Chemical Spill Kits" on the RLSS website for more information on chemical spill kit requirements.

8.1.5 Decontamination Equipment (Safety Shower & Eye Wash)

Laboratories should have access to an emergency shower and eye wash that takes no more than 10 seconds to reach. Faucet-mounted eyewashes may be purchased through Grainger, though these must be inspected by laboratory personnel on the same quarterly basis as plumbed stations.

In limited cases, RLSS may approve of the use of a dousing station instead of a full safety shower/eyewash station for a laboratory's use in case of a chemical spill or exposure. Contact RLSS for assessment if a full safety shower/eyewash station is not available in your laboratory and it is not feasible to install one.

Decontamination equipment must be unobstructed (i.e. a minimum of 16" clearance on all sides for showers and 6" for dousing/eye wash stations) and clearly labeled. Some laboratory facilities have been constructed with safety showers in the hallways outside of laboratories, as opposed to within each laboratory. In this case, every laboratory that refers to a shared safety shower or eye wash in their LCHP is responsible for ensuring they are properly inspected by Facilities Management.

8.2 Chemical Spills

Only knowledgeable and experienced personnel should clean a chemical spill. The knowledge and experience required for remediating a chemical spill will depend on whether it is classified as a minor or major chemical spill. This classification will also determine the spill response procedures that laboratory workers must take when a chemical spill occurs.

8.2.1 Major Spills

A chemical spill is considered a "major spill" if any of the following conditions are met:

- A person is injured by the spilled material;
- It is probable that this type of injury can happen to someone else;
- The chemical is highly toxic, pyrophoric, self-reactive, highly oxidizing, highly water-reactive or flammable (if the spill is near an ignition source);
- Chemical spilled is unknown;
- Multiple chemicals are involved or mixed;
- It occurs in a hallway or other public space;
- It has the potential to expose others in the building, such as through the ventilation system; or spill migration onto lower floors;
- Proper clean procedures are not known;
- Appropriate materials are unavailable;
- The cleanup requires the use of a respirator and workers are not in the RPP;
- It may endanger the environment through discharge to waterway (drain, river, etc.).

In the case of a **major** chemical spill:

1. Immediately alert others working in the area and evacuate if injury is possible, limit access to the affected area.
2. Attend to any injured or contaminated laboratory workers, **only if it will not cause you harm**:
    a. Move the injured personnel from the immediate area of any fire, explosion or spill (if this can be done without further injury to the victim or yourself).
        i. If the victim is contaminated with chemicals or on fire, bring them to the nearest emergency eyewash or shower, remove any contaminated clothing and flush all contaminated areas of the body with water for 15 minutes.

ii. Only remove clothing by cutting, not pulling; pulling over a person may further expose them.

b. Administer first aid if trained and/or seek immediate medical attention by calling 911.

3. If an uncontrolled fire, explosion, or leak of highly toxic (inhalation type hazard) chemical, activate the nearest fire alarm and call 911.
    a. Provide details on the spill, including the types of hazardous materials involved and how many people have been injured.
4. Contact your AH and ASC to inform them of the major spill, as soon as possible.
5. Call RLSS and RMS to report any injuries, as soon as possible.

8.2.2 Minor Spills

A chemical spill that does not meet any of the requirements of a major chemical spill is classified as a minor spill:

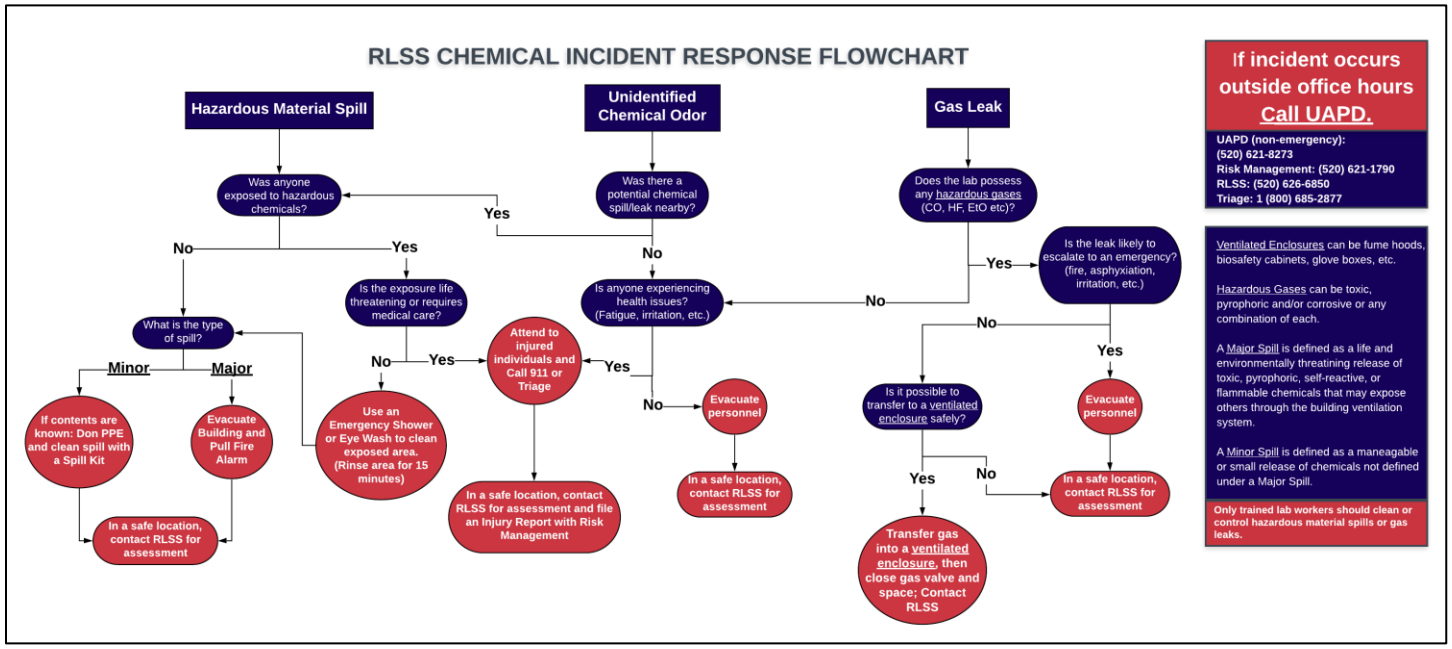
- The situation is contained,
- It is non-life threatening,
- Trained laboratory workers with proper cleanup equipment are on hand.

Laboratory workers may clean up the chemical spill themselves, if comfortable. Examples of minor chemical spills include knocking over a small vial of a solvent in a chemical fume hood, spilling a small amount of a non-toxic powder, and spilling a small quantity of a dilute acidic solution on the bench top or laboratory floor. Keep in mind that a minor spill may evolve into a major spill, and steps should be taken to respond to the major spill.

In the case of a **minor** spill:

1. Alert all present laboratory personnel of the spill.
2. Isolate the area, closing doors and evacuating the area if necessary.
    a. If the spill involved a flammable chemical, immediately turn off any sources of ignition in the laboratory.
3. Locate the chemical spill kit and don PPE.
4. Spread a neutralizing agent on spills of liquid acids and bases (i.e. sodium bicarbonate for most acids and citric acid/vinegar for most bases).
    a. Collect the residue using a dustpan and broom.
    b. Place in an appropriate solid waste container and dispose as chemical waste.
5. For solid chemical spills, use a dustpan and broom to collect the material and dispose of as solid chemical waste.
6. For non-corrosive liquid chemicals (i.e. not acids or bases), place absorbent material on top of the spill. Once absorbed, dispose of the absorbent material as solid chemical waste.
7. Clean any remnant chemical with the appropriate material, such as water for non-water reactive chemicals.

It is highly recommended that you contact RLSS even in the case of minor spills to ensure the right steps are taken in the cleanup of the spill. The spill event should be reviewed with all laboratory workers at the next laboratory meeting, as well as how to avoid the spill in the future.



RLSS Chemical Incident Response Flowchart; available for printing on the RLSS website.

8.3 Explosion/Fire Emergency

In the case of an explosion in the laboratory, leave the area immediately and call 911 as soon as possible.

In the case of a laboratory fire, assist any person in immediate danger if it can be accomplished without risk to you. Immediately activate the fire alarm system by pulling a manual fire alarm pull station, regardless of the severity of the fire. This will warn personnel to evacuate the building and notify the campus police and local fire department. It is best to have these agencies respond, even if they end up not being needed, then to have them arrive too late for potential rescue.

If you have been trained on the proper use of the available fire extinguisher, you should attempt to use a nearby fire extinguisher to extinguish the fire only if all of the following conditions are met:

- The fire is small (i.e. can be extinguished with only one fire extinguisher) and contained.
- Substance that is burning is known AND the available fire extinguisher is appropriate.
- There is a path available for you to reach the fire extinguisher and back quickly.
- The room is not full of smoke,
- There is a safe way of escape (e.g. the fire is not between you and the escape).
- Someone is aware that you have not evacuated after the fire alarm.

If any of the above conditions are not met, do not attempt to extinguish the laboratory fire; evacuate the building. When you hear a fire alarm, close all doors as you leave a room or laboratory. Do not wedge open laboratory doors, as they are built to prevent heat, smoke and toxic gases from entering passageways when closed. Do not use elevators when evacuating; use the building stairwells, again being sure to close doors behind you.

When using a fire extinguisher, remember to **P.A.S.S.**: **P**ull the pin, **A**im the fire extinguisher hose at the base of the fire, **S**queeze the handle to spray the contents and **S**weep the hose back and forth as you spray the base of the fire. Stand approximately 6 to 10 feet away from the fire to be effective. **Do not turn your back on an extinguished fire**, as it may reignite. If your first attempt to extinguish the fire does not succeed, evacuate the building immediately. If a fire extinguisher was used at all, inform your supervisor of its use so it may be recertified before it is used again.

Inform RLSS about any laboratory explosions, fires, or other incidents as soon as possible. RLSS will work with you to assess the conditions leading the incident to help prevent a future occurrence, never to assign blame or punish a worker. Your report may help someone avoid the same incident, injury, or worse in the future.

8.4 Chemical Exposure

If a laboratory worker is exposed to a hazardous chemical, they must immediately notify their coworkers in case they need assistance with obtaining care. Contact emergency services/care if the exposed person is either impaired or is in pain or discomfort. **RLSS and RMS must be informed as soon as possible**, in order to assist and meet all OSHA and workers' compensation requirements. If medical attention is necessary, the AH or ASC must follow the provisions defined in Section 9 and an SDS must be given to the healthcare providers for each chemical the worker was potentially exposed to.

Depending on the route of exposure and the extent of the exposure, the laboratory worker should perform specific first aid procedures defined in this section and in the chemical's SDS to remove the chemical from the body and decrease the exposure. Some chemicals have antidotes (e.g. calcium gluconate for hydrofluoric acid and selegiline for MPTP) that should be on hand in any laboratory where that chemical is used – refer to the SDS and contact RLSS for more information on possible antidotes.

Inform RLSS about any laboratory chemical exposures as soon as possible. RLSS will work with you to assess the conditions leading the incident to help prevent a future occurrence, never to assign blame or punish a worker. Your report may help someone avoid the same incident, injury, or worse in the future.

8.4.1 Hazardous Chemical Inhalation

In case of a hazardous chemical inhalation, the exposed person should immediately be moved to fresh air. If the exposed person is experiencing impairment, pain or difficulty breathing, call 911 for emergency medical attention. If the exposure is less severe, and the laboratory worker is left feeling ill or if there is persistent respiratory discomfort, the supervisor, call the UArizona Triage line at 1-800-685-2877 to determine if further medical action is required and afterwards, the Arizona Poison & Drug Information Center at (800)-222-1222 for more information.
If a laboratory worker is unconscious and may have been exposed, notify others of danger in the area and immediately move the unconscious worker to fresh air (if safe to do so). Contact 911 immediately.

If you have been trained in cardiopulmonary resuscitation (CPR), you may perform CPR as you wait for the emergency response/medical team; do not use mouth-to-mouth style CPR is a worker has been exposed. CPR training is available through Campus Recreation.

8.4.2 Skin Contact with Hazardous Chemicals

If hazardous chemicals contact the skin, the laboratory worker should immediately notify another worker to request assistance and notify the AH/ASC as soon as possible. Flush the contaminated area with copious amounts of water for at least 15 minutes, while removing all contaminated clothing. Flushing with water from a sink may suffice for contact with the hand or other easily accessible areas, while a safety shower may be required for contact with larger or hard-to-reach surfaces.
While flushing with water, another worker should call the triage line 1-(800) 685-2877 to determine if further medical action is required and afterwards, the Arizona Poison & Drug Information Center at (800) 222-1222 for more information. Contact emergency medical responders (911) if the laboratory worker continues to feel ill or if they experience persistent discomfort.

8.4.3 Eye Contact with Hazardous Chemicals

If hazardous chemicals come into contact with the eyes, the laboratory worker must immediately notify another worker to request emergency assistance and notify the AH/ASC. Remove contact lenses (if present) and irrigate the eyes with water for at least 15 minutes, while holding the eyelids open and rolling the eyes. While the exposed worker is flushing the eyes, the AH/ASC or other laboratory worker should contact emergency medical responders (911) for assistance. All ocular exposures need to be immediately evaluated by a medical professional.

8.4.4 Ingestion or Injection of Hazardous Chemicals

If hazardous chemicals are ingested or injected into a worker's body in any manner (e.g. needle stick, broken glass cut, etc.), the laboratory worker should immediately notify another laboratory worker to request assistance and notify the AH/ASC, then rinse the mouth with water or wash out the injection site with copious amounts of water. If it is a non-blood spurting puncture wound, the laboratory worker should force blood to exit the wound to remove chemical contaminants in the immediate injection site.

While the exposed worker is washing with water, the AH/ASC or another laboratory worker should call the triage line 1-(800) 685-2877 to determine if further medical action is required and afterwards, the Arizona Poison & Drug Information Center at 1-(800) 222-1222 for more information. If the laboratory worker feels ill or if there is persistent discomfort, the AH/ASC or another laboratory worker should contact emergency medical responders (911).

8.4.5 Open Wounds

If a fellow laboratory worker is bleeding severely, control the bleeding by compressing the wound with sterile gauze or a clean cloth and elevate the injury above the level of the heart. Notify the AH/ASC and contact emergency medical responders (911) as soon as possible.

If a laboratory worker receives a less severe cut, they should initially encourage bleeding and then wash the cut and remove any pieces of glass, if present. If the cut cannot be treated by first aid, the laboratory worker must get medical attention as soon as possible. Contact the triage line 1-(800) 685-2877 to determine if further medical action is required and afterwards, the Arizona Poison & Drug Information Center at 1-(800) 222-1222 for more information.

8.4.6 Burns

If a fellow laboratory worker suffers a burn, extinguish any burning clothing by using the emergency shower, a fire extinguisher, rolling him/her on the floor, dousing with water or wrapping him/her in a coat or blanket. Quickly remove any contaminated clothing. Flush burned areas with tepid (NOT cold) water to remove heat from the burn and continue to flush with water for at least 15 minutes if chemicals were involved. Place a clean, wet cloth on the burned area and contact emergency medical responders (911) as soon as possible (i.e. while the laboratory worker is flushing with water) if the burn is serious, extensive or if unsure of the extent of the burn. Contact the triage line 1-(800) 685-2877 for less serious burns to determine if further medical action is required.

8.5 Reporting Injuries

If a researcher (employee or non-employee) is injured in the laboratory workplace, 911 (life-threatening) or the UArizona Triage Line at 1-800-685-2877 must be contacted. **Contact both RLSS (520) 626-6850 and RMS (520) 621-1790 as soon as possible** for additional service and support. **The PI is obliged to report any and all injuries or illnesses, under OSHA regulations**. RLSS will investigate the event, assess hazards and collaborate with the laboratory to further reduce or eliminate the contributing risks involved. RMS will guide the PI through completing required OSHA reports and beginning a state insurance workman's compensation claim. RMS injury reporting procedures/manuals for employees and non-employees are maintained on the RMS website. Employee injury reporting must be completed on the RMS injury reporting portal.

9. Medical Consultations and Monitoring

OSHA sets enforceable exposure limits to protect workers against the health effects of exposure to certain hazardous substances. Recommended exposure limits are reported by other organizations (e.g. ACGIH, NIOSH, etc.) for a wider variety of hazardous substances. RLSS exposure monitoring and hazard assessment services compare laboratory exposures to any existing exposure limits and use these comparisons to make recommendations. UA Occupational Health (OH) administers the UArizona medical surveillance program and is advised about hazardous material use by RLSS.

9.1 Medical Consultations and Examinations

OSHA regulations state that all laboratory workers shall have the opportunity to receive medical attention, including any follow-up examinations, which the examining physician deems necessary under the following situations:

- An emergency event takes place in the laboratory, such as a spill, leak, explosion or other occurrence resulting in the likelihood of exposure.
- When a laboratory worker develops signs or symptoms associated with a hazardous chemical exposure in the laboratory.
- If exposure monitoring reveals that the airborne concentration of a hazardous chemical is above the action level or Permissible Exposure Limit (PEL) for a chemical regulated by OSHA.

9.1.1 Medical Consultation and Examination Requirements

All medical examinations and consultations shall be provided by a licensed health care provider at no cost to UA employees, their supervisor, or department. Unpaid/volunteer students injured in UArizona laboratories will be required to depend on their personal/student insurance for costs related to medical consultations and examination, typically requiring a small co-pay.
For laboratory workers on the Tucson main campus, medical examinations and consultations will either be coordinated through or provided by UA Occupational Health (OH) or Campus Health Services (CHS).

RLSS will advise AH's about medical surveillance requirements pursuant to use/possession of certain OSHA-regulated chemicals. When required, RLSS will provide a written hazard assessment which is required for registration into the RPP.

9.1.2 Information Provided to the Physician

The AH must provide the following information to the physician performing the examination or consultation:

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

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

9.1.3 The Physician's Written Opinion

The AH shall obtain a written opinion on the medical examination or consultation from the physician for UA employees. This written opinion shall include the following information but exclude specific findings of diagnoses unrelated to the occupational exposure.

- The results of the medical examination and any associated tests;
- Any medical condition which may be revealed in the course of the examination that may place the employee at increased risk as a result of exposure to a hazardous workplace;
- Any recommendation for further follow-up;
- A statement that the employee has been informed by the physician of the results of the consultation or medical examination, and any medical condition that may require further examination or treatment.

9.2 Exposure Monitoring

RLSS either performs or coordinates hazardous chemical exposure monitoring within the scope of laboratory chemical operations, procedures, or experiments for anyone who believes they may be or may have been exposed to hazardous chemicals. The need for exposure monitoring is assessed by RLSS and the PI/AH at routine inspections and addressed in the LCHP.

RLSS will perform an assessment of a laboratory worker's exposure to OSHA regulated hazardous chemicals if there is reason to believe that exposure levels routinely exceed exposure limits. If the assessment/monitoring suggests an overexposure, RLSS will assist the AH and laboratory workers with abating their exposure and complying with relevant OSHA regulations. Monitoring results will be communicated with the AH and laboratory workers within 15 working days after RLSS receives the monitoring results.

Contact RMS regarding air quality problems not known to be caused by hazardous chemicals (i.e. dust, mold, temperature, unexplained odors, carbon dioxide, etc.).

9.3 Pregnancy Counseling

It is strongly recommended that any pregnant person, or person who plans on becoming pregnant, that works with hazardous chemicals, obtain more detailed information on the hazards of workplace chemicals and ways to protect themselves and their unborn child. RLSS is available to provide basic information on the safe use of chemicals during their pregnancy; RLSS will likely refer pregnant workers to OH for clinical assessment/advice. Additionally, the University of Arizona College of Pharmacy has an "Arizona Pregnancy Riskline" that is a part of the Arizona Poison & Drug Information Center. To speak with a board-certified genetic counselor about the risks of using hazardous chemicals in your laboratory, call 1-888-285-3410.

10. Information and Training

RLSS and the AH of a hazardous chemical approval are responsible for providing all laboratory workers with information and training necessary to ensure they are aware of the hazards of chemicals present in their work area, as well as the control measures that are available to protect them from these hazards.

10.1 Information and Right to Know

Every laboratory worker has the right to access information about chemical safety, both in general and specific to the UArizona laboratory in which they work. Accessible information includes:

- The OSHA Standard 29 CFR 1910 (general industry regulations), particularly the 29 CFR 1910.1450 (Occupational Exposure to Hazardous Chemicals in Laboratories) and the 29 CFR 1910.1200 (Hazard Communication Standard)
- The location and availability of the UCHP and USOPs
- The location and availability of the LCHP and LSOPs
- An inventory of the hazardous chemicals in the laboratory or workplace
- The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals in the laboratory; this includes MSDSs (or SDSs) from the chemical supplier
- Exposure limits for hazardous chemicals in the laboratory, such as permissible exposure limits (PEL) regulated by OSHA
- Signs and symptoms associated with exposures to the hazardous chemicals in the laboratory

Laboratory workers have the right to request RLSS historical compliance data (previous inspection results and incidents) regarding any approval to which they are an authorized hazardous chemical worker.

10.2 Training

Personnel must be trained on the following information before they may work unsupervised in a laboratory using hazardous chemicals:

- The chemical hazards in the laboratory
- Ways to detect the presence or release of hazardous chemicals
- The protective measures one can take to prevent exposure to hazardous chemicals
- The UCHP and LCHP

This information is covered in the two training sessions required by the Laboratory Chemical Safety Program: the online General Chemical Safety Training provided by RLSS and Laboratory Specific Training provided by the AH or ASC of the laboratory. Additional training may also be required, depending on the job description of the laboratory worker and the particular hazards associated with the laboratory.

The training of laboratory workers should never end, but must be a regular, continuing activity.

10.2.1 General Chemical Safety Training

New laboratory workers must complete the online General Laboratory Chemical Safety Training (GLCST), which is available through the RLSS User Dashboard. The GLCST explains the Laboratory Chemical Safety Program, as defined by this plan, as well as the roles and responsibilities of key players, physical and health hazards, exposure control measures, hazard communication, hazardous chemical disposal, medical surveillance and recordkeeping.

10.2.2 Laboratory Specific Training

There are a wide variety of chemical-use laboratories across the University. Laboratory workers in a biological research laboratory who use chemicals on occasion will face drastically different hazards than those working in an organic synthesis laboratory. Because of this AND as mandated in OSHA regulation, laboratory specific training is required for each laboratory worker. This training must be documented by the lab and include information on the specific hazards, control measures and emergency procedures related to the laboratory. The AH or ASC must provide this training to all laboratory workers before they begin work with hazardous chemicals in the lab. A template for this training is available on the RLSS website. If you choose to not use this template, ensure all relevant information is included in your training and that the covered information is documented within the laboratory.

Additional training and information must be provided by the supervisor when new chemicals, processes, procedures or equipment presenting new classes of hazards are introduced to the laboratory.

10.2.3 Chemical Hygiene Plan Affirmations

Laboratory workers must affirm to understanding the relevance and purpose of this plan every time it is significantly updated. Affirmations are completed and tracked using the RLSS User Dashboard; workers are also reminded of required affirmations by this system. This keeps laboratory workers informed of current chemical hazard concerns, as well as changes to the UArizona Laboratory Chemical Safety Program.

Similar to UCHP affirmations, laboratory workers must read and affirm to the laboratory's LCHP upon each amendment using the RLSS User Dashboard. Affirmation to this document also includes an affirmation that the laboratory worker has received adequate laboratory-specific training from the AH or ASC and has had the opportunity to have any questions they may have answered.

If a laboratory worker does not feel they have received an effective and complete laboratory-specific training, they must contact the AH/ASC and ask relevant questions to successfully complete the training.

10.2.4 Other Training

Depending on the hazardous chemicals and control measures present in a laboratory, workers may be required to take additional training. For example, annual training and respirator fit testing is required through the RMS Respiratory Protection Program if respirators are used in the laboratory. Depending on the laboratory worker's role in the laboratory, they may be required to either complete the RMS Fire Extinguisher or Fire Awareness Training.
In addition, manufacturers or vendors of certified devices using hazardous chemicals may require specific training on the use and/or maintenance of the device.

10.2.5 Training for Laboratory Visitors

Any laboratory visitor (e.g. visiting professor) working with hazardous chemicals in a laboratory for ≥2 weeks must be a registered under a PI's approval hazardous chemical approval and complete all required chemical safety training (both RLSS and lab-specific) and plan affirmations. Visiting researchers are the responsibility of the AH, and will be listed as a laboratory worker under the Approval as long as they are actively working in the laboratory. AH's must work with their department to ensure that they rapidly complete the necessary coordination to attain Designated Campus Colleague (DCC) status for such visitors, as they will need a University NetID to join the approval, complete RLSS chemical safety training, and access the RLSS User Dashboard.

Any laboratory visitor working in a laboratory with hazardous chemicals for <2 weeks does not need to be listed on the hazardous chemical approval. They must, however, receive documented laboratory-specific training and have access to laboratory safety information (chemical inventories, SDS's & LCHP). Laboratory visitors must be supervised in the laboratory at all times by a trained/authorized hazardous chemical user.

10.2.6 Safety Orientation

At times, the AH or ASC may be required to provide a chemical safety orientation to UA personnel whose workplace is not the laboratory (e.g. administrators, neighboring researchers in open-bay laboratories, maintenance staff, plumbers, etc.). Safety orientations should include a basic overview of the hazards present in the laboratory and control measures applicable to that non-laboratory worker (e.g. plumbers wearing safety glasses & acid resistant gloves when disconnecting parts of the laboratory sink). These safety orientations are not recorded by RLSS; they should be documented by the AH in case of inspection or incident. It is acceptable to use Laboratory Specific Training Form for this purpose, completed by every approval hosting the visitor.

11. Recordkeeping

Maintaining accurate records of events that occur in a laboratory, as well as applicable records of laboratory workers themselves, is essential for a safe hazardous chemical laboratory environment. The OSHA Occupational Exposure to Hazardous Chemicals in Laboratories requires that the AH establishes and maintains an accurate record of the following information for each laboratory worker, including themselves:

- Laboratory worker training (laboratory-specific training and other required training)
- Measurements taken to monitor laboratory worker exposures
- Employee medical consultation and examinations including tests or written opinions
- Copies of outside registrations and licenses (e.g. DEA, ATF)

In addition to these OSHA requirements, AH's at UArizona are required to maintain documentation of the items listed below. To aid in the recordkeeping process, this information is maintained by RLSS and can be accessed on the AH's online RLSS User Dashboard at any time.

- List of active workers and authorized chemical use and storage laboratories
- Laboratory worker training (the RLSS General Chemical Safety Training and laboratory-specific training only)
- Amendments to the LCHP
- A current hazardous chemical inventory
- A current SDS library

12. Compliance with the Laboratory Chemical Safety Program

12.1 RLSS Inspections

12.1.1 Initial Visit/Laboratory Safety Orientation

Principal Investigators may register into the Laboratory Chemical Safety Program by completing the "New Lab Registration and Assessment" form available online. Upon receipt of this form, RLSS will contact the AH to schedule an initial visit. At the initial visit/laboratory safety orientation, a member of the RLSS staff will explain the Laboratory Chemical Safety Program and provide the AH with the "Laboratory Safety Getting Started Guide." The RLSS staff member may complete a baseline assessment of laboratory compliance with chemical safety regulations and any hazard control measures required to protect laboratory workers from exposure. The RLSS staff member will provide onsite guidance about the identified hazard control measures that must be implemented in the laboratory and will be available to answer any questions. Any required labels and signs will be posted at this time.

Following the first formal visit, RLSS will provide the AH with a report summarizing the initial visit. The scheduled month of the first formal audit (scheduled with the AH and/or ASC during the initial visit) will also be detailed in this report. Any required corrective measures will be listed in attached checklists. The implementation of these corrective measures, completion of a hazardous chemical inventory for each room used for chemical use or storage, and development of a LCHP must be implemented by the time of the first formal audit. Contact RLSS for assistance in completing the inventory or developing the LCHP

12.1.2 Routine Inspections

Formal laboratory chemical safety audits are conducted routinely by RLSS chemical safety staff; all audits are planned and scheduled with the AH and/or ASC in advance. When scheduled, RLSS will provide the AH/ASC with a copy of the Laboratory Safety Inspection Checklist, which provides the laboratory requirements that will be reviewed during the audit. RLSS may also perform additional inspections or assessments as needed or requested (e.g. when an AH reports certain changes in chemical inventory, use or procedures).

Any findings shall be verbally relayed to the AH/ASC, if present at the conclusion of the inspection. A written inspection report, stating the results of the inspection and required corrective actions, will be generated by the inspector and provided to the AH; the report will also be shared with the ASC. All life-threatening findings or concerns must be rectified by the AH immediately. Activities associated with life or health-threatening conditions must cease until the conditions are corrected. Subsequent follow-up inspections to determine laboratory compliance progress will be scheduled with the AH and/or ASC. The severity of the non-compliance issue(s) will dictate the follow-up scheduling timeline.

12.2 Regulatory Agencies

Occasionally, regulatory agencies (i.e. Arizona Division of Occupational Safety and Health) will perform inspections of the Laboratory Chemical Safety Program and UA laboratories. Inspections by regulatory agencies are typically not announced or scheduled in advance. RMS is the designated liaison for the Arizona Division of Occupational Safety and Health (ADOSH) and other regulatory agencies on behalf of UArizona. RLSS acts as a support and information resource during these inspections, and may serve as a liaison between the laboratory and the regulatory agency/RMS.

For compliance inspections by the Environmental Protection Agency (EPA), Arizona Department of Environmental Quality (ADEQ), ADOSH, Pima County Department of Environmental Quality (PDEQ), and Pima County Wastewater Management (PCWM), a combination of persons from both RMS and RLSS will typically accompany inspectors. If an individual requests access to a UA laboratory for inspection and is not accompanied by RMS or RLSS staff, laboratory occupants are required to verify credentials of the inspector, and contact RMS and RLSS immediately to send a representative.

12.3 Shutdown of Dangerous Activity

The RLSS Senior Director, Assistant Director, EHS Manager(s) or designee is authorized to provisionally curtail or cease the operation of any UA laboratory considered to constitute an imminent, serious danger to health, safety, and/or the environment. Formal approval for the action must be sought from the SVPR/VPO within 24 hrs to continue the action.

In the event of such curtailment or shutdown, the Senior Vice President for Research (SVPR), Vice President for Research Operations, AH, department head, applicable dean, RLSS, and RMS shall be immediately notified of the action and the factors leading to that decision. In the case of a dispute, an order to curtail or shut down will remain in effect until the SVPR (or designee) determines in writing that the danger has passed, mitigated, or that the order should be rescinded for other reasons.

12.4 Close-Out Procedure for Departing Research Groups

Departmental administrators and/or AHs must coordinate laboratory close-out procedures for the permanent departure of any laboratory research group to ensure all hazardous materials have been either donated to another responsible party or properly disposed. Typically, this occurs when an AH leaves UArizona or moves to a different laboratory. Procedures may vary by department, but the departing research group must always work with the RMS to ensure any hazardous chemicals without a recent, immediate or foreseen research purpose (unnecessary chemicals) are appropriately disposed or distributed.

Departing research groups that will be leaving behind hazardous chemicals to be transferred to other researchers, disposed of through RMS, or distributed in some other way, must notify RLSS in writing prior to their departure. Ideally, this procedure will take place prior to the research

group or AH leaving UArizona or a laboratory and before the laboratory space is reassigned. A similar close-out procedure may be followed by laboratory workers, supervisors or department administrators when they discover that a research group that has left UArizona and left behind hazardous waste in a laboratory. If you plan to leave UArizona or vacate a laboratory, or discover unnecessary hazardous chemicals in your laboratory, please notify RLSS at 520-626-6850 to initiate close-out procedures.

12.4.1 Use of third-party Hazardous Material Handling Companies

Occasionally, professional hazardous material remediation companies become involved with laboratory, building and facility closures. These services are typically used to decontaminate facilities, remove hazardous waste, and prepare a site for renovation or closure. Any hazardous materials handling by a third-party vendor must be coordinated with Risk Management Services (Hazardous Waste Manager) and RLSS prior to any work conducted on-site.

Appendix A: Definitions

Action Level: A concentration designated in the 29 CFR part 1910 for a specific substance, as an eight-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance. An action level is not the same as a Permissible Exposure Level (PEL), and while PELs are never to be exceeded, exceeding an action level merely requires additional control measures.

American Conference of Governmental Industrial Hygienists (ACGIH): A professional association of industrial hygienists and practitioners of related professions. They publish Threshold Limit Values (TLVs) for hazardous chemicals that act as recommended exposure limits.

American National Standards Institute (ANSI): A non-profit organization that oversees the creation, promulgation and use of norms and guidelines in every aspect of businesses, including chemical use laboratories.

Approval Holder (AH): Usually a faculty member or principal investigator that maintains Chemical Safety approval through RLSS and the LCSC for a laboratory or set of laboratories that use or store hazardous chemicals.

Approval Safety Coordinator (ASC): A laboratory worker that is designated by the Approval Holder to undergo advanced chemical safety training, help with the responsibilities of the AH and to enforce chemical safety in the laboratory. The ASC also has delegated authority from the AH to be a main point of contact for RLSS.

ATF Permittee: Any user of explosive materials for a lawful purpose who has obtained either a user permit or limited permit through the ATF.

Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF): A law enforcement agency in the United States Department of Justice that protects communities from violent criminals, criminal organizations, the illegal use and trafficking of firearms, the illegal use and storage of explosives, acts of arson and bombings, acts of terrorism and the illegal diversion of alcohol and tobacco products.

CAS Registry Number: A unique numerical identifier assigned by the Chemical Abstracts Service to every chemical described in the open scientific literature.

Chemical Hygiene Plan: A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that

(i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and
(ii) meet the requirements of the OSHA Occupational Exposure to Hazardous Chemicals in Laboratories.

At the University, both a University Chemical Hygiene Plan (UCHP) and specific Laboratory Chemical Hygiene Plans (LCHPs) are required to comply with the OSHA Occupational Exposure to Hazardous Chemicals in Laboratories Standard.

Combustible liquid: Any liquid having a flashpoint at or above 100°F (37.8°C), but below 200°F (93.3°C).

Compressed Air: Compressed gas mixture containing 79.1% nitrogen and 20.9% oxygen which may accelerate/support combustion. Compressed air presents no greater oxidation hazard than that of the atmospheric air and thus is not an oxidizing gas.

Compressed Gas: A compressed gas may be either of the following:

(i) a gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C), 104 psi at 130°F (54.4°C), or
(ii) a liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C).

Contact (Eye & Skin) Hazard: A chemical that causes irritation, toxicity or fatality after contact with either the skin or eyes.

Controlled Substance: A drug or other substance, or immediate precursor, included in schedule I, II, III, IV or V, as defined in Subchapter I, Part B of Title 21 United States Code (USC) Controlled Substances Act. This does not include distilled spirits, wine, malt beverages or tobacco.

Corrosive: A chemical that causes serious burns or damage to the eyes or skin, or corrosion to metals.

Drug Enforcement Administration (DEA): A law enforcement agency in the United States Department of Justice responsible for the enforcement of laws and regulations governing narcotics and controlled substances.

DEA Agent: An individual who has been formally identified by a DEA Registrant to have access to controlled substances under that registration.

DEA Registrant: An individual who is registered with the DEA to obtain and use controlled substances.

Delayed Health Hazard: A chemical that may cause an allergic skin or respiratory reaction, may cause cancer, or that causes target organ effects due to prolonged or repeated exposure.

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

Developmental & Reproductive Toxin: A chemical that may cause genetic defects, damage fertility or cause harm to the unborn child, or cause harm to children through breastfeeding.

Department of Transportation (DOT): The United States DOT regulates the shipment and transport of hazardous materials, including hazardous chemicals.

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

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

Explosive Material: Any chemical compound mixture, or device, the primary or common purpose of which is to function by explosion, such as explosives, blasting materials and detonators.

Federal Explosives Licensee (FEL): A FEL is an individual who is licensed with ATF to import, manufacture or deal in explosive materials.

Flammable: A chemical that falls into one of the following categories:

(i) flammable aerosol – an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
(ii) flammable gas – a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% by volume or less; or a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12% by volume, regardless of the lower limit;
(iii) flammable liquid – any liquid having a flashpoint below 100°F (37.8°C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99% or more of the total volume of the mixture;
(iv) flammable solid – a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and, when ignited, burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a greater than one-tenth of an inch per second along its major axis.

Globally Harmonized System (GHS): The Globally Harmonized System is a system of classification and labeling of chemicals that has been adopted by OSHA to define and classify the health and physical hazards of chemicals, and to communicate this hazard information, as well as protective measures, through labels and Safety Data Sheets (SDSs).

Hazard Control Measure: A method of reducing laboratory worker exposure to hazardous chemicals.

Hazard Pictogram: A composition that may include a symbol plus other graphic elements, such as a border, background pattern, or color, that is intended to convey specific information about the hazards of a chemical. Eight pictograms are designated under this standard for application to a hazard category.

Hazard Statement: A hazard statement is assigned to a hazard class and category under the GHS that describes the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard.

Hazardous Chemical: A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees, or that a physical hazard exists.

Hazardous Chemical-Use Laboratory: A laboratory in which all of the following conditions are met:

- Chemical manipulations are carried out on a laboratory scale.
- Multiple chemical procedures or chemicals are used.
- The procedures involved are not part of a production process.
- Protective laboratory practices and equipment are available and in common use to minimize the potential for laboratory worker exposure to "hazardous chemicals."

This definition includes both research and teaching laboratories. Laboratory procedures which provide no potential for personal chemical exposure are excluded. Examples of such procedures include: procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing color reaction to a color chart supplied by the manufacturer of the test strip, and some commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

Hazardous Drug: Drugs that have shown potential to cause cancer, reproductive toxicity, birth defects or organ damage at low doses in either human or animal studies.

Hazardous Gas: A compressed gas that is toxic, highly toxic, pyrophoric, a known carcinogen or reproductive toxin, corrosive, or has a history of being abused and that requires approval from RLSS prior to ordering.

Health Hazard: Includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes or mucous membranes.

Highly Reactive: Includes chemicals that are flammable or explosive upon heating, pyrophoric, self-heating and water-reactive. These chemicals react violently with little or no influence from the laboratory worker.

Immediately Dangerous to Life and Health (IDLH): An atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual’s ability to escape from a dangerous atmosphere, as defined by OSHA.

Ingestion Hazard: Includes chemicals that are irritating, harmful, toxic or fatal to a person via ingestion. This hazard class also includes chemicals that act as an aspiration hazard (fatal if swallowed and enters airways) and chemicals that can cause damage to organs.

Inhalation Hazard: Includes chemicals that are irritating, harmful, toxic or fatal to a person via inhalation. This hazard class also includes chemicals that cause damage to organs.

Irritant: A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by a chemical action at the site of contact.

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: This describes work with substances in which the containers are 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 Worker: A laboratory worker is anyone authorized by an Approval Holder who works or volunteers in a chemical research laboratory at UArizona and uses hazardous chemicals.

Unnecessary chemicals: Chemicals recognized by native researchers and their departments as having no recent, immediate or foreseen research purpose.

Magazine: A storage container specifically designed and constructed to store explosive materials. See 7.3ATF Regulated Explosive Materials for more information.
Material Safety Data Sheet (MSDS): A written or printed material concerning a hazardous chemical which is prepared in accordance with the OSHA Hazard Communication Standard.

Mutagen: A chemical that changes the genetic material, usually DNA, of a person and thus increases the frequency of mutations above the natural background level.

Nanomaterials: Materials with two or three dimensions and ranging in size from 1-100 nanometers in size, which can be naturally-occurring or engineered. Nanomaterials encompass nanoplates, nanofibers, nanoparticles, nanoaerosols, etc. The name nanomaterial has historically been used synonymously with the term ultrafine particles (typically indicating a naturally occurring nanomaterial).

National Institute for Occupational Safety and Health: The United States' federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. NIOSH is part of the Centers for Disease Control (CDC).

Occupational Safety and Health Administration (OSHA): OSHA is a federal administration under the United States Department of Labor that works to assure safe working environments by setting and enforcing standards.

Organic Peroxide: An organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer: Includes chemicals, other than a blasting agent or explosive, that initiates or promotes combustion in other materials, thereby causing fire either by themselves or through the release of oxygen or other gases.

Oxidizing Gas: Gases that can contribute to combustion by acting as an oxygen source or those containing oxygen at higher than atmospheric concentrations (i.e., above 23-25 percent). These gases can react rapidly and violently with combustible materials or flammable vapors.

Particularly Hazardous Chemical: Includes chemicals that act as select carcinogens, reproductive toxins and substances that have a high degree of acute toxicity.

Passively Ventilated Area: A non-hermetically sealed area without climate control or mechanical air movement (e.g. barn, shed).

Permissible Exposure Limit (PEL): These are legal limits for exposure of an employee to a chemical substance or physical agent. They exist for OSHA regulated substances, and are usually given as a time-weighted average (average exposure over an 8-hour period) or as a short-term exposure limit (average exposure over a 15-minute period).

Peroxidizable: A chemical which will form organic peroxides when exposed to air.

Personal Protective Equipment: Equipment worn by laboratory workers to minimize exposure to a variety of hazards.

Physical Hazard: Includes chemicals for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable or water-reactive.

Precautionary Statement: A phrase and/or pictogram that describes recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to a hazardous chemical, or improper storage or handling of a hazardous chemical. These are found on Safety Data Sheets and sometimes on the labels of hazardous chemicals.

Principal Investigator (PI): A researcher in charge of a grant or an experiment or project. Due to their direct supervisory role in University laboratories, PIs often become Chemical Safety Approval Holders.

Reproductive Toxin: Includes chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Safety Data Sheet (SDS): Similar to Material Safety Data Sheets, a Safety Data Sheet is a written or printed material concerning a hazardous chemical. The information contained in any Safety

Data Sheet has been unified by the Global Harmonization Standard, to create a more uniform hazard communication system.

Select Carcinogen: Any substance that meets the following criteria:

(i) it is regulated by OSHA as a carcinogen,
(ii) it is listed under the category "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP),
(iii) it is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC),
(iv) it is listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals.

Sensitizer: Includes chemicals that cause a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical(s).

Toxic: Includes chemicals that are poisonous. They are capable of causing injury or death after exposure.

Unventilated Area: A hermetically sealed area separated from the general building climate control/ ventilation (e.g. cold room).

Use of Hazardous Chemicals: Handling or use of hazardous 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 equipment and laboratory practices are available and in common use to minimize the potential for worker exposure to hazardous chemicals.

Ventilated Area: A room within a climate-controlled area, building or facility (e.g. laboratory with or without air supply and return). There must be detectable air exchange between the ventilated room and the rest of the building.

Visiting Student: A student who is part of an approved educational experience or program, who performs tasks primarily for academic purposes, while potentially/concurrently advancing the laboratory's research. Contact RLSS for specific documentation/training requirements.

Volunteer: A hazardous chemical laboratory worker who, although uncompensated, performs tasks to advance the laboratory's research.

Water-Reactive: Includes chemicals that react with water to release a gas that is either flammable or presents a health hazard.

Well-Ventilated Area: A non-hermetically sealed room within a climate controlled area with mechanical air movement creating significant (≥ 6 air changes per hour) air exchange between the room and the building (e.g. laboratory with air supply and return).

Appendix B: UArizona Standard Operating Procedures

B-1 Chemical Hazard Class SOP for Explosives

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with explosive chemicals in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using explosive chemicals. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the explosive hazard of a chemical; several hazard class SOPs may be applicable for a specific chemical. In addition, some explosive chemicals may fall under the regulatory purview of the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) or UArizona Export Control Office. If you are using an explosive chemical that falls under one of these categories, refer to the University Chemical Hygiene Plan for additional requirements.

3. Hazard Description

Explosives are chemicals or combinations of chemicals that may cause a sudden release of pressure, gas and heat when subjected to sudden shock, pressure or high temperature. This hazard class is not to be confused with the "explosive materials" regulated by the ATF, which are designed with the primary function to explode.

Common chemical explosives include acetylides, azides, organic nitrates, nitro compounds and organic peroxides. The explosive nature of compounds may vary widely; some are set off by the action of a metal spatula on the solid (e.g. organic azides) and others may decompose explosively when exposed to a ground glass joint (e.g. diazomethane). Organic peroxides are considered to be both explosives and highly reactive chemicals; refer to both hazard class SOPs for work with these chemicals.

4. General Control of Hazards

The following general control measures must be implemented whenever using or handling explosive chemicals:

- Limit your inventory of explosive chemicals, especially "azos", peroxides and peroxidizables; use minimum amounts in experiments.
- Keep away from heat, sparks, open flames and hot surfaces.

- Consult the SDS. Do not handle explosive chemicals until all safety precautions have been read and understood.
- When planning a reaction, consider the potential for explosion and plan accordingly.
- If drying out increases the explosion hazard of a chemical, keep the chemical wetted.
- If the explosive is electrostatically sensitive, ground/bond the container and receiving equipment.
- Immediately discard any organic compounds that are prone to peroxidation (e.g. secondary alcohols) that become contaminated.
- Do not subject the chemical to grinding, shock or friction.

5. Engineering Controls

Explosive chemicals should be used in a chemical fume hood (or other ventilated enclosures) whenever possible. Safety shields (i.e. blast-protective shields) must be used when:

- a reaction is attempted for the first time (small quantities should be used to minimize hazards),
- a familiar reaction is carried out on a significantly larger scale than usual (e.g. 5-10 times more material), or
- operations are carried out at increased temperature and/or pressure.

Safety shields must be placed so all laboratory workers in the area are protected from the explosion hazard. These shields or barricades can provide protection not only against the exploding chemicals, but any flying particles that may result from the explosion. Shields should also be used when performing a reaction that will be left unattended for a period of time. If your laboratory is performing unattended reactions, you must also adhere to the Unattended Reaction SOP and post the Unattended Reaction Form (available on the RLSS website) in a visible location near the experiment.

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory. Laboratory personnel working with explosive chemicals or performing an experiment that may lead to an explosion, must also wear a full-face shield over their safety glasses. Blast-protective clothing (e.g. aprons) may be required, depending on the amounts and stability of the explosives used. Heavy leather gloves may be required if it is necessary to reach behind a shielded area while the experiment is in progress.

7. Handling and Storage Requirements

Store explosive chemicals away from incompatible materials, including flammable materials and oxidizers. Ideally, this segregation would occur via separate cabinets. If space is limited, however, storing all compatible explosives in sealed secondary containment (i.e. plastic trays or Tupperware) within the same cabinet as incompatible chemicals is acceptable. Consult the SDS for more specific information on compatibility.

Record the opening date and the date the chemical should be discarded on the label of chemicals that may degrade to become potentially explosive (e.g. organic peroxides).

8. Waste Disposal

Dispose of explosive chemicals as soon as possible; explosive waste should not be allowed to accumulate. Contact Risk Management Services for further information on the disposal of explosive chemicals.

9. Spill and Incident Procedures

In the case of a spill of explosive chemicals, do not attempt to clean the spill yourself. Evacuate the area and follow the procedures illustrated in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.

In the case of an explosion in the laboratory, leave the area immediately and call 911 from a campus phone, or call 911 from a non-campus phone and mention the incident is on UArizona campus.

If a laboratory worker is injured or exposed to explosive chemicals, immediately notify the AH/ASC. If a laboratory worker requires immediate medical attention, call 911. Remove contaminated clothing and immediately flush the contaminated areas with water for at least 15 minutes. For eye exposures, immediately remove contact lenses, if present, and flush the eyes with water for at least 15 minutes. Consult the chemical's SDS for more specific information on appropriate first aid. Inform RLSS and Risk Management Services of the incident as soon as practicable.

10. Designated Area

Designated areas are not required for this hazard class. However, chemicals may belong to multiple hazard classes, and an explosive chemical may require a designated area if it belongs to a hazard class that includes particularly hazardous chemicals.

B-2 Chemical Hazard Class SOP for Flammables

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with flammable chemicals in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using flammable chemicals. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the flammable hazard of a chemical; several hazard class SOPs may be applicable for a specific chemical. For the purposes of laboratory safety, both flammable and combustible liquids are considered to be in the "Flammable" hazard class, and are covered under this SOP.

3. Hazard Description

Flammable chemicals are easily ignited and are capable of burning rapidly. The following flammability hazards are included in this SOP:

- Flammable gas
- Flammable aerosol
- Flammable liquid
- Flammable solid
- Combustible liquid

Common flammable chemicals include acetone, ethanol, cyclohexane, and methanol. The flammability of a liquid chemical will depend on its flash point, or the temperature at which an organic compound gives off sufficient vapor to ignite in air. The lower the flash point, the more flammable the chemical. Flash points are commonly found on the chemical's SDS.

4. General Control of Hazards

The following general control measures should be implemented whenever using or handling flammable chemicals:

- Keep away from heat, sparks, open flames and hot surfaces.
- Never heat flammable chemicals with an open flame. If the temperature must be increased, use an oil or water bath.
- Avoid using ignition sources (e.g. Bunsen burners, hot plates, oil baths, electrical equipment with frayed or cracked wiring, etc.) in areas where highly flammable (i.e. low flash point) chemicals are used.
- Avoid creating static electricity in areas where highly flammable chemicals are used.

- Keep the containers of flammable chemicals tightly closed at all times when not in use to prevent accumulation of flammable vapors.
- Ensure proper grounding. Be sure to ground metal containers when transferring flammable liquids.
- Do not pierce or burn pressurized containers of flammable aerosols, even after use.

5. Engineering Controls

Flammable and combustible chemicals should be used in a chemical fume hood (or other similarly ventilated area) whenever possible. This is especially true for highly flammable chemicals, large quantities (> 500mL) of flammable chemicals, or when using flammable chemicals at increased temperature or pressure.

Fire extinguishers should be immediately available in the laboratory when working with flammable chemicals. Ensure the fire extinguisher is appropriate for the chemicals used; the wrong fire extinguisher may not work against a fire, or worse, may make the fire larger. Type ABC fire extinguishers are appropriate for most laboratory settings, but a Class D fire extinguisher is required for fires involving combustible metals (e.g. magnesium, titanium, sodium, potassium).

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory. Laboratory personnel working with large quantities of flammable chemicals, or with any quantity of a flammable chemical near an ignition source, must wear a 100% cotton or flame-resistant laboratory coat. A poly/cotton blend laboratory coat will not protect your skin against flammable hazards. If the splashing of flammable liquids is a possibility during your work, splash goggles must be worn instead of safety glasses.

7. Handling and Storage Requirements

Store flammable materials in a well-ventilated place and keep them cool. Segregate flammable chemicals from incompatible materials, such as oxidizers, corrosives, combustibles, etc. In laboratories or storage rooms where more than 10 gallons of flammable chemicals are stored, these chemicals must be stored in an approved flammable storage cabinet. Ensure there are no combustible materials (e.g. paper, cardboard, etc.) also stored in flammable storage cabinets that may act as fuel for a fire. A maximum of 60 gallons of flammable liquid may be stored within a single flammable storage cabinet, and no more than 3 flammable storage cabinets may be kept in a laboratory/fire area. An exception to this rule exists if the storage room qualifies as an “inside storage room” per International Fire Code. Contact RLSS for further information on inside storage rooms.
If a flammable chemical must be kept below room temperature, the refrigerator/freezer used for storage must be an approved explosion-proof or modified-domestic device. Flammable chemicals should not be stored in regular, domestic refrigerators/freezers.

Flammable chemicals must be transported in secondary containment, preferably a polyethylene or other non-reactive acid/solvent bottle carrier. Suitable fire control devices (e.g. fire extinguishers) must be available in laboratories or storage rooms where flammable or combustible chemicals are located.

8. Waste Disposal

Waste flammable chemicals should be collected in compatible waste containers (i.e. plastic 3.5-gallon buckets) and segregated from incompatible chemicals. Contact Risk Management Services for further information on the disposal of flammable chemicals.

9. Spill and Incident Procedures

If a spill of flammable chemicals constitutes a major spill (e.g. it occurs near an ignition source), do not attempt to clean the spill yourself. Evacuate the area and follow the procedures illustrated in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.

In the case of an explosion or fire in the laboratory, leave the area immediately and call 911 from a campus phone, or call 911 from a non-campus phone and mention the incident is on UArizona campus.

If a laboratory worker is injured or exposed to flammable chemicals, immediately notify the AH/ASC. If a laboratory worker requires immediate medical attention, call 911. Remove contaminated clothing and immediately flush the contaminated areas with water for at least 15 minutes. For eye exposures, immediately remove contact lenses, if present, and flush the eyes with water for at least 15 minutes. Consult the chemical's SDS for more specific information on appropriate first aid. Inform RLSS and RMS of the incident as soon as practicable.

10. Designated Area

Designated areas are not required for this hazard class. However, chemicals may belong to multiple hazard classes, and a flammable chemical may require a designated area if it belongs to a hazard class that includes particularly hazardous chemicals.

B-3 Chemical Hazard Class SOP for Oxidizers

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with oxidizing chemicals in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using oxidizers.

If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the oxidizing hazard of a chemical; several hazard class SOPs may be applicable for a specific chemical.

3. Hazard Description

Oxidizers are chemicals that may react violently when they come into contact with reducing agents (e.g. zinc, hydrazine, formic acid), or combustible materials. They initiate or promote combustion in other materials, generally by the rapid release of oxygen.

Examples of oxidizing chemicals include halogens, chlorates, nitrates, chromates, persulfates and peroxides. Strong oxidizers (e.g. calcium chlorate, hydrogen peroxide, potassium bromate) are capable of forming explosive mixtures with combustible, organic or reducing materials.

4. General Control of Hazards

The following general control measures should be implemented whenever using or handling oxidizers:

- Minimize the quantities of oxidizers used and stored in the laboratory.
- Keep oxidizing materials away from heat, flammables and potential fuels such as clothing and other combustible materials.
- Use caution when mixing oxidizers with flammable, combustible, or reducing materials for an experiment. Use small amounts to allow better control of the reaction and heat generation.

5. Engineering Controls

Oxidizing chemicals should be stored and used in a well-ventilated area. Perchloric acid must be used in a special chemical fume hood that is equipped with wash down facilities. Contact RLSS for more information on fume hood requirements for the use of this chemical.
Safety shielding is required any time there is a risk of an explosion, splash hazard or highly exothermic reaction. This shielding requirement may be met by performing the experiment in a chemical fume hood, with the sash at is lowest possible position. Portable blast shielding is acceptable, as long as it may be reasonably effective at protecting all laboratory workers in the area.

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory.
Laboratory personnel working with oxidizing chemicals when a splash hazard exists must wear splash goggles instead of safety glasses. Chemical-resistant gloves may be necessary if working

with the oxidizing chemical for an extended period of time. Refer to the Personal Protective Equipment Selection Guide on the RLSS website for further information on appropriate chemical-resistant gloves.

7. Handling and Storage Requirements

Store oxidizing gases in a cool, dry, well-ventilated place away from flammable and combustible materials such as solvents, wood, paper, Styrofoam, and plastics. Oxidizing agents should also be segregated from reducing agents (e.g. zinc, alkaline metals, etc.), as they can react violently with oxidizers. Since combustible materials (i.e. wood, paper, etc.) are great fuels for oxidizers, oxidizing chemicals should not be stored in wooden cabinets or on wooden shelves.
Secondary containment must be used when storing strong oxidizing acids, such as perchloric acid and chromic acid. Cylinders of oxidizing gases must be fitted with flow reduction valves and fittings free from oil and grease (these are great combustible fuels for oxidizers).

8. Waste Disposal

Waste oxidizing chemicals should be collected in compatible waste containers (i.e. plastic 3.5 gallon buckets) and segregated from incompatible chemicals. Contact Risk Management Services for further information on the disposal of flammable chemicals.

9. Spill and Incident Procedures

Laboratory personnel may clean a spill of small amounts of oxidizers only if the spill does not involve a reactive mixture and they have appropriate materials and training. Before beginning spill cleanup, alert all laboratory workers in the area of the spill of oxidizing chemicals. Do not use paper towels or other inappropriate combustible materials to clean a spill of oxidizing chemicals; consider the use of other absorbents (e.g. vermiculite).
If the spill of oxidizing chemicals is large or contains a reactive mixture, do not attempt to clean the spill yourself. Evacuate the area and follow the procedures in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.
In the case of an explosion in the laboratory, evacuate the area immediately and call 911 from a campus phone, or call 911 from a non-campus phone and mention the incident is on UArizona campus (if on the main Tucson campus). If there is a fire in the laboratory containing oxidizing chemicals, either contain the fire using an approved fire extinguisher, or pull the fire alarm if the fire is not quickly extinguished by building/laboratory fire control equipment.

If a laboratory worker is injured or exposed to oxidizing chemicals, immediately notify the AH/ASC. If a laboratory worker requires immediate medical attention, call 911. Remove contaminated clothing and immediately flush the contaminated areas with water for at least 15 minutes. For eye exposures, immediately remove contact lenses, if present, and flush the eyes with water for at least 15 minutes. Consult the chemical's SDS for more specific information on appropriate first aid. Inform RLSS and RMS of the incident as soon as practicable.

10. Designated Area

Designated areas are not required for this hazard class. However, chemicals may belong to multiple hazard classes, and an oxidizer may require a designated area if it belongs to a hazard class that includes particularly hazardous chemicals.

B-4 Chemical Hazard Class SOP for Compressed Gases

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with compressed gases in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using compressed gases. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the high-pressure hazard of a chemical. The gases within the cylinder may pose additional hazards, such as flammability, corrosivity, toxicity, etc. Consult the SDS for each compressed gas and refer to the other hazard class SOPs that may apply to the gas's hazards.

3. Hazard Description

Compressed gases present a physical hazard due to the high pressures within the gas cylinders. Even if a compressed gas does not present a physical or health hazard beyond the high pressure (e.g. compressed nitrogen, etc.), the volume of the gas may fill the room in the case of a leak, creating an oxygen-deficient atmosphere.

Cryogenic materials (e.g. liquid nitrogen) are also included within the scope of this SOP, as cryogenic dewars contain gases under high pressure. Cryogenic materials can cause tissue damage due to extreme cold and can create an inhalation hazard in poorly ventilated areas due to boil off or spill. Please Appendix B-17 for further information on the use and storage of inert cryogenic materials.

4. General Control of Hazards

The following general control measures should be implemented whenever using or handling compressed gases:

- All compressed gas cylinders must be legibly marked with the chemical name of the contained material (cylinder color does not constitute chemical identity), manufacturer identification and a UA identifier (most commonly a barcode).
- When using a highly flammable or toxic gas, check the delivery system with an inert gas before introducing the hazardous gas.
- Corrosive gases should not be kept for longer than 1 year. The recommended shelf life of all other gases is 2 years.
- Check connections and hoses regularly for leaks using instrumentation, soapy water, etc.

5. Engineering Controls

Cylinders of hazardous gases may require additional engineering controls, such as a ventilated enclosure for use and storage, restricted flow orifices for regulators, and gas detection monitors. See the Use of Hazardous Gases SOP for further information on requirements for toxic, pyrophoric, or corrosive gases.

Cryogenic dewars may need to be secured; RLSS will provide guidance for securing dewars on a case-by-case basis. The storage of cryogenic materials in a laboratory or storage room may require the installation and use of oxygen monitors. Examples of situations where oxygen monitors may be required include freezer bays and hypoxia chamber rooms.

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory. Laboratory personnel working with cryogenic materials should wear cryogenic-resistant gloves rather than examination-type gloves. Chemical resistant gloves should be considered if working with a gas that is hazardous to the skin. Refer to the Personal Protective Equipment Selection Guide on the RLSS website for further information on appropriate chemical-resistant gloves.
If the compressed gas is corrosive, laboratory workers must wear splash goggles instead of safety glasses.

7. Handling and Storage Requirements

Only the gas cylinders necessary for experiments or procedures in the laboratory should be stored within the laboratory itself. Fire code limits compressed gas users to storing only one “stand-by” cylinder, per gas, in a work area. All others, including empty cylinders, must be promptly returned to the University Research Instrumentation Center (URIC) Cryogenics & Gas Facility, or disposed of as hazardous waste. Compressed gas cylinders must be secured to a wall or other sturdy structure by chains, or by a cylinder stand/clam shell, in accordance with the limitations and intent of the cylinder securing device’s manufacturer. If a gas cylinder is not secured to a wall (i.e. with an approved stand), it must be secured so as not to be in danger of being knocked over by foot traffic. Compressed gas cylinders must remain upright, whether in storage or use. The valve protection cap must be fully screwed onto the gas cylinder when not in use.

Protect gas cylinders from sunlight and store them in a well-ventilated place. Gas cylinders containing anything other than compressed air must not be stored in cold rooms or other unventilated areas. Ensure proper regulators and piping are being used for the gas in each cylinder.

Segregate compressed gases by type and compatibility. Empty gas cylinders should be segregated from full, or partially full, cylinders. Gas cylinders that are empty must still be stored and secured as if they were full.

Flammable gas cylinders must only be used with flame-resistant gas lines and hoses (stainless steel recommended) and be stored at least 20 feet away from oxygen/oxidizing (concentrations of

oxygen in excess of atmospheric concentration) gas cylinders and other oxidizing gases. Spark-less tools and regulators (e.g. brass) should be used with all flammable gas cylinders. Wear googles or face shield, 100% cotton or flame-resistant lab coat, and consider usage of a blast shield (contact RLSS to determine if fume hood sash may be acceptable). Open flames should not be proximal to flammable gas cylinders and/or lines. Ensure flammable gas equipment and lines are properly grounded and bonded.

Compressed gas cylinders must be transported using hand-trucks or other appropriate means. Cylinders must be secured to the hand-truck by straps or chains. They should be transported in their upright position whenever possible.

8. Waste Disposal

Cylinders should not be refilled by the laboratory; the URIC Cryogenics & Gas Facility or other authorized vendors can transfill cylinders upon request. Lecture bottles of compressed gases are collected by Risk Management Services for disposal. The removal of all other cylinders is performed by the URIC Cryogenics & Gas Facility. Contact Risk Management Services, the URIC Cryogenics & Gas Facility or your local gas vendor (especially for off-campus satellite locations) for the disposal of unwanted or empty compressed gases.

Disconnecting and disposing of hazardous gases may require the use of approved protective equipment (i.e. SCBA gear) and specialized training. For further information, contact RLSS or the URIC Cryogenics & Gas Facility.

9. Spill and Incident Procedures

Laboratory personnel must keep antidotes for hazardous gases on hand, whenever antidotes exist (e.g. calcium gluconate for HF gas).

Immediately evacuate the area in the event of a spill or leak of a compressed gas that is an irritant, oxidizer, asphyxiant, or has other hazardous properties. Follow the procedures in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.

If there is a fire or explosion in the laboratory, leave the area immediately and call 911 from a campus phone, or call 911 from a non-campus phone and mention the incident is on UArizona campus.
If a laboratory worker is injured or exposed to a hazardous gas, immediately notify the AH/ASC. If they require immediate medical attention, call 911. Move the laboratory worker to fresh air. If the skin was exposed to corrosive or toxic gas, remove contaminated clothing and immediately flush the contaminated areas with water for at least 15 minutes. For eye exposures, immediately remove contact lenses, if present, and flush the eyes with water for at least 15 minutes. Consult the chemical's SDS for more specific information on appropriate first aid. Inform RLSS and RMS of the incident as soon as practicable.

10. Designated Area

Designated areas are not required for this hazard class. However, chemicals may belong to multiple hazard classes, and a compressed gas may require storage and use in a designated area if it belongs to a hazard class that includes particularly hazardous chemicals (e.g. ammonia gas).

B-5 Chemical Hazard Class SOP for Highly Reactive Chemicals

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with highly reactive chemicals in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using highly reactive chemicals. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the high reactivity hazard of a chemical; several hazard class SOPs may be applicable for a specific chemical. Organic peroxides are considered to be both explosives and highly reactive chemicals; refer to both hazard class SOPs for work with these chemicals.

3. Hazard Description

Highly reactive chemicals are those that, under certain circumstances, are unstable and may cause a physical hazard. The following hazards are included within this hazard class:

- Self-reactive: Chemicals outside of the explosive, oxidizing, and organic peroxide classifications that undergo a highly exothermic (heat-releasing) decomposition in the presence of heat
    - Ex: Arsine, Diborane, Hydroxylamine, etc.
- Pyrophoric: Chemicals that ignite, even in small quantities, when exposed to air
    - Ex: Silane gas, Dichloroborane, White phosphorous, etc.
- Self-heating: Chemicals, other than pyrophorics, that self-heat when exposed to air, even in the absence of an energy supply such as a hot plate
    - Ex: Magnesium, Sodium sulfide, etc.
- Organic peroxides: Chemicals that may be liable to explosive decomposition, burn rapidly, be sensitive to impact/friction, or react dangerously with other substances
    - Ex: Hydrogen peroxide, Diethyl ether, Tetrahydrofuran, etc.
- Water-reactive: Chemicals that either react violently or release a toxic (or flammable) gas upon contact with water
    - Ex: Calcium oxide, Phosphorous pentachloride, Sodium, Potassium, etc.

Peroxides are some of the most common and most shock-sensitive chemicals found in laboratories. Organic peroxides supply both the oxygen and the fuel source required to start a fire; all they need is a spark. Some chemicals are naturally occurring organic peroxides (e.g. hydrogen peroxide). However, others can form peroxides with air, moisture, impurities, or even time during regular storage (e.g. isopropyl ether, diethyl ether). Once peroxides have been formed, an explosion can occur when distilling, concentrating or evaporating these chemicals. Explosions can even be caused by twisting off a cap of a reagent bottle if peroxides formed between the threads of the cap.

4. General Control of Hazards

The Highly Reactive Chemicals hazard class includes a wide variety of hazards. Though basic control measures may be implemented for the class as a whole, the SDS of highly reactive chemicals should be consulted for specific information on hazard controls and safety measures. The following general control measures should be implemented whenever using or handling highly reactive chemicals:

- Whenever possible, use a less hazardous alternative chemical to complete the experiment.
- Minimize the quantity and/or concentration of highly reactive chemicals used or synthesized to the smallest amount immediately needed for an experiment.
- Plan experiments involving highly reactive chemicals carefully, including consulting the SDS(s). Do not handle highly reactive chemicals until all safety precautions have been read and understood.
- Ensure an appropriate fire extinguisher is nearby before using highly reactive chemicals.
- All containers of highly reactive chemicals should be dated as soon as they are received, and never opened after their expiration date.
- Combine highly reactive chemicals to other chemicals slowly, watching for increased heat or release of gases.
- Consider the additional hazards of scaled-up reactions that may not be obvious on a smaller scale.
- Consult your AH/ASC if you are working with a new chemical, or if you are unsure of the safety precautions required for the highly reactive chemical.
- Provide a mechanism for adequate temperature control and heat dissipation when handling these chemicals.

5. Engineering Controls

Since many highly reactive chemicals liberate a flammable and/or toxic gas when exposed to water vapor or air, they must be used in a chemical fume hood to prevent exposure to these gases.

If a chemical is air-sensitive, it should be used in a glove box under an inert atmosphere. If a glove box is not available, consult your AH/ASC on how to control the hazards involved with air-sensitive highly reactive chemicals.

Utilize safety barricades or shields if there is a possibility of an explosion or violent chemical reaction. Place these barricades so that all laboratory workers in the area are protected from the explosion hazard.

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory. Laboratory personnel working with any highly reactive chemicals should wear splash goggles, instead of safety glasses, as well as a 100% cotton or flame-resistant laboratory coat. Heavy gloves

and safety barricades should also be considered, depending on the amount and stability of the chemicals being used.

7. Handling and Storage Requirements

Store any highly reactive chemicals away from flammable or combustible materials where they cannot fall or be knocked over easily. Do not store these chemicals in temporary containers (e.g. vials, jars, beakers, etc.); keep them in their original containers. Label all highly reactive chemicals with the date received and the date the container was opened. Because of their high degree of reactivity, only the amount of these chemicals needed for immediate use should be brought into the laboratory. The chemicals' SDSs may be used to obtain specific storage requirements and precautions.

7.1 Self-reactive, Pyrophoric, and Self-heating chemicals: Store self-reactive, pyrophoric and self-heating chemicals at low temperatures away from direct sunlight, heat, sparks, open flames and hot surfaces. Because pyrophoric chemicals can ignite spontaneously when in contact with air, they must be handled under an inert atmosphere and in a way that prevents exposure to air. Extra care must always be taken when using these chemicals, and laboratory workers should consult their AH/ASC before using them in a laboratory.

Pyrophoric chemicals should be stored under an inert atmosphere or solvent to prevent exposure to air. Storage locations may include inert gas-filled desiccators or glove boxes. If a pyrophoric chemical must be stored below room temperature, the refrigerator/freezer must be an explosion-proof or modified domestic piece of equipment. Only those laboratory workers who have been trained on how to handle highly reactive chemicals should have access to storage areas containing pyrophoric materials.

7.2 Organic peroxides: Store organic peroxides at low temperatures, but not at temperatures below the temperature at which they freeze. The sensitivity of most peroxides can be decreased by diluting them with an inert solvent (e.g. hexane). Do not allow contact of peroxides with metal lab ware, tools or equipment.

Peroxide-forming chemicals should be kept away from heat and sunlight and their containers should be tightly sealed after each use. Refrigeration does not prevent peroxide formation. Containers of peroxide-forming chemicals should be labeled with the date received and the date opened. Because of the high potential for fires and explosions, these chemicals must be disposed of one year after the opening of the container, or by the expiration date (whichever is sooner). Laboratory personnel can test for the presence of peroxides to extend the shelf-life by one year.

7.3 Water-reactive chemicals: Store water-reactive chemicals in closed container in a dry place away from water, sources of water (e.g. sinks and safety showers) and water-containing chemicals (e.g. aqueous buffers, diluted acids). Containers of water-reactive chemicals should be tightly sealed and water-tight.

8. Waste Disposal

Waste highly reactive chemicals should be collected in compatible containers and segregated from incompatible chemicals. Do not dispose of pure organic peroxides; rather, dilute the peroxides before disposal with water. Dispose of peroxide-forming chemicals one year after the open date or at the expiration date, whichever is sooner. Contact Risk Management Services for further information on the disposal of highly reactive chemicals.

9. Spill and Incident Procedures

Do not attempt to clean up a spill of self-reactive, self-heating, pyrophoric or water-reactive chemicals yourself. Evacuate the area and follow the procedures in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.
In the case of an explosion or fire in the laboratory, leave the area immediately, pull the fire alarm, and call 911 from a campus phone (or call 911 from a non-campus phone and mention the incident is on a UA campus).

If a laboratory worker is injured or exposed to highly reactive chemicals, immediately notify the AH/ASC. If a laboratory worker requires immediate medical attention, call 911. Remove contaminated clothing and immediately flush the contaminated areas with water for at least 15 minutes. For eye exposures, immediately remove contact lenses, if present, and flush the eyes with water for at least 15 minutes. Consult the chemical's SDS for more specific information on appropriate first aid. Inform RLSS and RMS of the incident as soon as practicable.

10. Designated Area

Designated areas are not required for this hazard class. However, chemicals may belong to multiple hazard classes, and a highly reactive chemical may require a designated area if it belongs to a hazard class that includes particularly hazardous chemicals.

B-6 Chemical Hazard Class SOP for Corrosives

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with corrosive chemicals in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using corrosives. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the corrosive hazard of a chemical; several hazard class SOPs may be applicable for a specific chemical.

3. Hazard Description

Corrosive chemicals (i.e. acids and bases) cause visible destruction or permanent damage of skin or tissue at the point of contact. They can also be corrosive to metals. Corrosives can be liquids, solids or gases, and can therefore affect the skin, eyes and respiratory tract. Three general categories of corrosive chemicals exist: acids, bases, and dehydrating agents. Common examples of highly corrosive chemicals are hydrochloric acid, sodium hydroxide, chlorine gas, and phosphorous.

4. General Control of Hazards

The following general control measures should be implemented whenever using or handling corrosive chemicals:

- Wash hands thoroughly after handling corrosive chemicals.
- Do not breathe dusts or mists if inhalable particles may be created during use.
- Do not pour water into a liquid corrosive. Slowly add the corrosive to the water and stir.

5. Engineering Controls

Corrosive chemicals should be used in a chemical fume hood when used in high concentrations, or when the chemical, or reactions with the chemical, may produce an airborne hazard such as a gas, mist or fume.

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory. Laboratory personnel working with large quantities of corrosive chemicals, or with any quantity in a way that may generate a splash hazard, must wear splash goggles instead of safety glasses. Chemical-resistant gloves may be necessary if working with corrosive chemicals in high quantities

or for an extended period of time. Refer to the Personal Protective Equipment Selection Guide on the RLSS website for further information on appropriate chemical-resistant gloves.

7. Handling and Storage Requirements

Liquid acids and bases may react violently with one another if they come into contact, depending on their strength and concentration. Concentrated, strong liquid acids and bases must be stored in corrosion-resistant secondary containment that can hold the full amount of chemicals being stored. Secondary containment may be built into the storage location (i.e. approved corrosive cabinets) or may be added to a storage area (e.g. plastic trays or Tupperware). Segregate concentrated strong acids and bases from each other, either in separate cabinets or with secondary containment. Nitric acid should be stored in separate secondary containment from other concentrated acids, such as acetic acid and hydrochloric acid.

Corrosive materials (acids and bases) must be stored below eye level, and should not be stored in flammable storage cabinets (with the exception of organic acids such as acetic acid, lactic acid and formic acid, in which case secondary containment is required). The corrosive materials may cause serious damage to the flammable cabinet and the other chemicals inside. Corrosives should be stored in separate areas from organic chemicals and flammable/combustible materials. Large quantities of corrosive chemicals should be stored in specially designated corrosive-resistant cabinets. It is recommended to label the outside of corrosive cabinets with hazard warnings, such as “Acids,” “Bases” or “Corrosives.”

8. Waste Disposal

Dispose of corrosive chemicals as aqueous hazardous waste (unless they are contaminated with other non-aqueous chemicals), in appropriate waste containers (i.e. plastic 3.5 gallon buckets) and segregated from incompatible chemicals. Contact Risk Management Services for further information on the disposal of hazardous chemicals.

9. Spill and Incident Procedures

Laboratory personnel may clean a small spill of corrosive chemicals themselves, as long as appropriate neutralizing materials (i.e. sodium bicarbonate for acids and citric acid for bases) and personal protective equipment are on hand, and workers have appropriate training. Neutralizing materials must be added to the spill slowly; the neutralization reaction may be exothermic (heat producing), and can cause more damage than the original spill if it occurs too rapidly. Once the addition of more neutralizing material does not generate signs of a reaction (i.e. heat, bubbling, etc.), the spill may be swept up and disposed of as hazardous waste.

If the spill of corrosive chemicals is large or contains a reactive mixture, do not attempt to clean the spill yourself. Evacuate the area and follow the procedures in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.

If a laboratory worker is injured or exposed to corrosive chemicals, immediately notify the AH/ASC; call 911 if the laboratory worker needs immediate medical attention. Remove contaminated clothing and immediately flush the contaminated areas with water for at least 15 minutes. For eye exposures, immediately remove contact lenses, if present, and flush the eyes with water for at least 15 minutes.

Due to the high hazards associated with certain corrosive chemicals, additional safety precautions may be required in the laboratory, including the application of antidotes (e.g. calcium gluconate for HF gas). Consult the chemical's SDS for more specific information on appropriate first aid. Inform RLSS and RMS of the incident as soon as practicable.

10. Designated Area

Designated areas are not required for this hazard class. However, chemicals may belong to multiple hazard classes, and a corrosive chemical may require a designated area if it belongs to a hazard class that includes particularly hazardous chemicals (e.g. hydrofluoric acid).

B-7 Chemical Hazard Class SOP for Inhalation Hazards

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with chemicals that present an inhalation hazard in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using chemicals that present an inhalation hazard. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the inhalation hazard of a chemical; several hazard class SOPs may be applicable for a specific chemical.

3. Hazard Description

This hazard class includes chemicals that may be hazardous to a laboratory worker via inhalation. While this class ranges from chemicals that are irritating, harmful, toxic and fatal to laboratory workers, the mode of entry for this class is the same: inhalation. This classification allows for the determination of hazard controls required to protect laboratory workers from inhalation hazards. This hazard class also includes chemicals that cause, or may cause, damage to organs after inhalation.

Chemicals that are fatal to laboratory workers if inhaled are considered to be particularly hazardous chemicals by OSHA. However, it is important to note that not every chemical under this hazard class is a particularly hazardous chemical.

4. General Control of Hazards

The following general control measures should be implemented whenever using or handling chemicals which pose an inhalation hazard:

- Plan experiments involving inhalation hazards carefully, including consulting the SDS(s). Do not handle chemicals that present inhalation hazards until all safety precautions have been read and understood.
- Minimize the quantity and/or concentration of these chemicals used or synthesized to the smallest amount immediately needed for an experiment.
- Do not breathe dust, fumes, gas, mist, vapors or sprays when handling these chemicals.
- Use and store only in well-ventilated areas.
- Keep containers tightly closed and sealed.

5. Engineering Controls

A certified chemical fume hood must be used when handling chemicals that present an inhalation hazard, especially those that are toxic or fatal if inhaled. In some cases, other local ventilation or containment devices may be used to adequately control the inhalation hazard (i.e. glove box/glove bag, snorkel, gas cabinet, etc). The use of a chemical monitor/alarm may be required for chemicals that present an inhalation hazard (e.g. ammonia gas, carbon dioxide gas, etc.). For additional information on engineering control options, contact RLSS or your AH/ASC.

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory. If chemicals that present an inhalation hazard cannot be used in a ventilated enclosure (i.e. chemical fume hood) due to experimental restrictions, laboratory workers should consider participation in UArizona Respiratory Protection Program (RPP), administered by Risk Management Services Department. This is especially true for chemicals that are toxic or fatal if inhaled. Contact RLSS to perform a hazard assessment of your experimental procedures to determine if respiratory protection should be used. An RLSS hazard assessment report is required prior to registration into the RPP.

7. Handling and Storage Requirements

When working with highly toxic chemicals, or poisons, prevention of accidental release becomes even more important than usual. Chemicals that are fatal if they are inhaled should be securely stored; access to these chemicals should be restricted.

Segregate chemicals that are fatal or toxic if inhaled from non-toxic materials. Ideally, this segregation would occur via separate cabinets. If space is limited, however, storing chemicals that are fatal or toxic in secondary containment (i.e. plastic trays or Tupperware) within the same cabinet as other chemicals is acceptable.

Particularly hazardous chemicals (i.e. those that are fatal upon inhalation) must be stored and used within a labelled designated area. If you are unsure if a chemical constitutes a particularly hazardous chemical, be conservative and treat them as if they are.

Carefully plan the transportation of chemicals that are fatal or toxic if inhaled. Handling chemicals outside of the laboratory area should be minimized, but when necessary, wear full personal protective equipment and carry the chemicals in unbreakable secondary containment.

8. Waste Disposal

Hazardous chemical waste that presents an inhalation hazard should be collected in compatible waste containers (i.e. plastic 3.5 gallon buckets) and segregated from incompatible chemicals. Some particularly hazardous chemicals may require special decontamination and disposal procedures. Contact Risk Management Services for further information on the disposal of chemicals.

9. Spill and Incident Procedures

Laboratory personnel may clean a small spill of chemicals that present an inhalation hazard themselves, as long as they wear appropriate personal protective equipment and have appropriate training. If the spill is large, occurs with a chemical that is fatal if inhaled, requires a respirator for cleanup, or occurs in a public area, do not attempt to clean the spill yourself. Evacuate the area and follow the procedures in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.

If a laboratory worker is injured or exposed to a chemical that is toxic or fatal by inhalation, immediately notify the AH/ASC; call 911 if the laboratory worker needs immediate medical attention. Move the laboratory worker to fresh air. If the exposed laboratory worker is experiencing extreme pain or difficulty breathing, they should get immediate medical attention. If the exposure is less severe, and the laboratory worker is feeling ill or if there is persistent respiratory burning, they should call the Arizona Poison & Drug Information Center at 626-6016 for information to determine if further medical action is required. Inform RLSS and RMS of the incident as soon as practicable.

If a fellow laboratory worker's breathing has stopped after exposure to a chemical that is toxic or fatal after inhalation, and you have been trained in cardiopulmonary resuscitation (CPR), perform artificial respiration as you wait for the emergency response team. Consult the chemical's SDS for more specific information on appropriate first aid.

10. Designated Area

Chemicals that are fatal upon inhalation are considered to be particularly hazardous chemicals. Because of this, some chemicals in this hazard class will require the designation of an area for their use and storage. All laboratory workers must know the location of these designated areas, and must use or store particularly hazardous chemicals only within them. Designated areas also require posting with the "Designated Area Label," which can be found on the RLSS website.

B-8 Chemical Hazard Class SOP for Contact (Skin or Eye) Hazards

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with chemicals that present a health hazard through contact with the skin or eyes in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using chemicals that present a contact hazard. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the hazards of a chemical presented by contact with the skin or eyes; several hazard class SOPs may be applicable for a specific chemical.

3. Hazard Description

This hazard class includes chemicals that may be hazardous to a laboratory worker upon contact with the skin or eyes. While this class ranges from chemicals that are irritating, harmful, toxic and fatal to laboratory workers, the mode of entry for this class is the same: skin or eye contact. This classification allows for the determination of hazard controls required to protect laboratory workers from contact hazards. This hazard class also includes chemicals that cause, or may cause, damage to organs after contact with the skin or eyes.

Chemicals that are fatal to laboratory workers upon contact are also considered particularly hazardous chemicals. However, it is important to note that not every chemical under this hazard class is a particularly hazardous chemical.

4. General Control of Hazards

The following general control measures should be implemented whenever using or handling chemicals which pose a contact (eye & skin) hazard:

- Plan experiments involving chemicals that are toxic upon contact carefully, including consulting the SDS(s). Do not handle chemicals that present contact (eye & skin) until all safety precautions have been read and understood.
- Minimize the quantity and/or concentration of these chemicals used or synthesized to the smallest amount immediately needed for an experiment.
- Do not get in eyes, on skin or clothing.
- Wash hands thoroughly after handling.
- Do not bring contaminated work clothing out of the laboratory.

5. Engineering Controls

Chemicals that present a health hazard through contact with the skin or eyes must be used in a laboratory that is negatively pressured in relation to any public spaces. Contact RLSS or Facilities Management to determine if your laboratory is negatively pressured.
Particularly hazardous chemicals (i.e. those that are fatal if in contact with the skin or eyes) must be used within a certified chemical fume hood or other approved ventilated enclosure.

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory.
Laboratory personnel working with chemicals that present a contact hazard through the skin or eyes should wear splash goggles instead of safety glasses. Double gloving with examination-type gloves, or the use of chemical resistant gloves, should also be used. Liquid-resistant chemical aprons should be considered when working with liquid chemicals that present a hazard via skin absorption, especially if there is a high probability of splashing. Refer to the Personal Protective Equipment Selection Guide on the RLSS website for further information on appropriate chemical-resistant gloves and liquid-resistant aprons.

7. Handling and Storage Requirements

When working with highly toxic chemicals, or poisons, prevention of accidental release becomes even more important than usual. Chemicals that are fatal if they come in contact with the skin or eyes should be securely stored; access to these chemicals should be restricted.

Segregate chemicals that are fatal or toxic upon contact with the skin or eyes from non-toxic materials. Ideally, this segregation would occur via separate cabinets. If space is limited, however, storing chemicals that are fatal or toxic in secondary containment (i.e. plastic trays or Tupperware) within the same cabinet as other chemicals is acceptable.

Particularly hazardous chemicals (i.e. those that are fatal upon contact with the skin or eyes) must be stored and used within a labelled designated area. If you are unsure if a chemical constitutes a particularly hazardous chemical, be conservative and treat them as if they were.
Carefully plan the transportation of chemicals that are fatal or toxic upon contact. Handling chemicals outside of the laboratory area should be minimized, but when necessary, wear full personal protective equipment and carry the chemicals in unbreakable secondary containment.

8. Waste Disposal

Hazardous chemical waste that presents a contact (eyes & skin) hazard should be collected in compatible waste containers (i.e. plastic 3.5 gallon buckets) and segregated from incompatible chemicals. Some particularly hazardous chemicals may require special decontamination and

disposal procedures. Contact Risk Management Services for further information on the disposal of chemicals.

9. Spill and Incident Procedures

Laboratory personnel may clean a small spill of chemicals that present a contact (eyes & skin) hazard themselves, as long as they wear appropriate personal protective equipment and have appropriate training. If the spill is large, requires a respirator for cleanup, or occurs in a public area, do not attempt to clean the spill yourself. Evacuate the area and follow the procedures in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.

If a laboratory worker is injured or exposed to a chemical that is toxic or fatal by inhalation, immediately notify the AH/ASC; call 911 if the laboratory worker needs immediate medical attention. Remove contaminated clothing and immediately flush the contaminated areas with water for at least 15 minutes. For eye exposures, immediately remove contact lenses, if present, and flush the eyes with water for at least 15 minutes. Consult the chemical's SDS for more specific information on appropriate first aid. Inform RLSS and RMS of the incident as soon as practicable.

10. Designated Area

Chemicals that are fatal upon contact with the skin are considered to be particularly hazardous chemicals. Because of this, some chemicals in this hazard class will require the designation of an area for their use and storage. All laboratory workers must know the location of these designated areas, and must use or store particularly hazardous chemicals only within them. Designated areas also require posting with the "Designated Area Label," which can be found on the RLSS website.

B-9 Chemical Hazard Class SOP for Ingestion Hazards

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with chemicals that present an ingestion hazard in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using chemicals that present an ingestion hazard. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the ingestion hazard of a chemical; several hazard class SOPs may be applicable for a specific chemical.

3. Hazard Description

This hazard class includes chemicals that may be hazardous to a laboratory worker upon ingestion of the chemical. Direct ingestion of a hazardous chemical in a laboratory setting is highly unlikely. However, touching the mouth with contaminated hands can also cause ingestion of hazardous chemicals. Chemical vapors and particles can also settle on food and drink in the laboratory and become ingested.

While this class ranges from chemicals that are irritating, harmful, toxic and fatal to laboratory workers, the mode of entry for this class is the same: ingestion. This classification allows for the determination of hazard controls required to protect laboratory workers from ingestion hazards. This hazard class also includes chemicals that cause, or may cause, damage to organs after ingestion, as well as chemicals that act as an aspiration hazard (may be fatal if swallowed and the chemical enters the airways).

Chemicals that are fatal to laboratory workers upon ingestion are classified as particularly hazardous chemicals by OSHA. However, it is important to note that not every chemical under this hazard class is a particularly hazardous chemical.

4. General Control of Hazards

The following general control measures should be implemented whenever using or handling chemicals which pose an ingestion hazard:

- Plan experiments involving chemicals that present an ingestion hazard carefully, including consulting the SDS(s). Do not handle chemicals that present ingestion hazards until all safety precautions have been read and understood.
- Minimize the quantity and/or concentration of these chemicals used or synthesized to the smallest amount immediately needed for an experiment.
- Wash hands thoroughly after handling.

5. Engineering Controls

Chemicals that present an ingestion hazard must be used in a laboratory that is negatively pressured in relation to any public spaces. Contact RLSS or Facilities Management to determine if your laboratory is negatively pressured.
Particularly hazardous chemicals (i.e. those that are fatal if ingested) must be used within a certified chemical fume hood or other approved ventilated enclosure.

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory. Laboratory personnel working with chemicals that present an ingestion hazard should wear double examination gloves or use chemical-resistant gloves. Refer to the Personal Protective Equipment Selection Guide on the RLSS website for further information on appropriate chemical-resistant gloves. If the experimental protocols generate a splash hazard, use of higher levels of eye protection (e.g. splash goggles, face shield, etc.) should be considered.

7. Handling and Storage Requirements

When working with highly toxic chemicals, or poisons, prevention of accidental release becomes even more important than usual. Chemicals that are fatal if ingested should be securely stored; access to these chemicals should be restricted.

Segregate chemicals that are fatal or toxic if ingested from non-toxic materials. Ideally, this segregation would occur via separate cabinets. If space is limited, however, storing chemicals that are fatal or toxic in secondary containment (i.e. plastic trays or Tupperware) within the same cabinet as other chemicals is acceptable.

Particularly hazardous chemicals (i.e. those that are fatal upon ingestion) must be stored and used within a labelled designated area. If you are unsure if a chemical constitutes a particularly hazardous chemical, be conservative and treat them as if they were.

Carefully plan the transportation of chemicals that are fatal or toxic upon ingestion. Handling chemicals outside of the laboratory area should be minimized, but when necessary, wear full personal protective equipment and carry the chemicals in unbreakable secondary containment.

8. Waste Disposal

Hazardous chemical waste that presents an ingestion hazard should be collected in compatible waste containers (i.e. plastic 3.5-gallon buckets) and segregated from incompatible chemicals. Some particularly hazardous chemicals may require special decontamination and disposal procedures. Contact Risk Management Services for further information on the disposal of chemicals.

9. Spill and Incident Procedures

Laboratory personnel may clean a small spill of chemicals that present an ingestion hazard themselves, as long as they wear appropriate personal protective equipment and have appropriate training. If the spill is large, requires a respirator for cleanup, or occurs in a public area, do not attempt to clean the spill yourself. Evacuate the area and follow the procedures in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.

If a laboratory worker is injured or exposed to a chemical that is toxic or fatal by inhalation, immediately notify the AH/ASC; call 911 if the laboratory worker needs immediate medical attention. Remove contaminated clothing and immediately flush the contaminated areas with water for at least 15 minutes. Call the Arizona Poison & Drug Information Center at 1-800-222-1222 for information to determine if further medical action is required. If the laboratory worker feels ill or if there is persistent burning or extreme pain, they should get medical attention as soon as possible. Consult the chemical's SDS for more specific information on appropriate first aid. Inform RLSS and RMS of the incident as soon as practicable.

10. Designated Area

Chemicals that are fatal upon ingestion are considered to be particularly hazardous chemicals. Because of this, some chemicals in this hazard class will require the designation of an area for their use and storage. All laboratory workers must know the location of these designated areas, and must use or store particularly hazardous chemicals only within them. Designated areas also require posting with the "Designated Area Label," which can be found on the RLSS website.

B-10 Chemical Hazard Class SOP for Delayed Health Hazards

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with chemicals that present a delayed health hazard in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using chemicals that present a delayed health hazard. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the delayed health hazards of a chemical; several hazard class SOPs may be applicable for a specific chemical.

3. Hazard Description

This hazard class includes health hazards that may appear over a prolonged or repeated exposure to a chemical. Some of the chemicals within this hazard class are classified as particularly hazardous chemicals by OSHA (i.e. select carcinogens), but not every chemical under this hazard class is a particularly hazardous chemical. The following hazard types are included in this SOP:

- Skin sensitizer: Chemicals that cause people to develop an allergic reaction in normal tissue after exposure to the substance through skin contact
    - Ex: Latex, Formaldehyde, etc.
- Respiratory sensitizer: Chemicals that induce hypersensitivity of the airways following inhalation
    - Ex: Acrylonitrile, Nickel(II) chloride, Sodium dichromate, etc.
- Carcinogen: Chemicals that can initiate or speed the development of cancer in normal tissue
    - Ex: 2-Mercaptoethanol, Benzene, Ethylene oxide, etc.
- Target organ toxin from prolonged or repeated exposure: Chemicals whose toxicity targets specific organs after repeated or prolonged exposure after inhalation, ingestion or skin/eye contact
    - Ex: Asbestos, Cadmium, Nitrobenzene, etc.

4. General Control of Hazards

The Delayed Health Hazard class includes a wide variety of hazard types. Though basic control measures may be implemented for the class as a whole, the SDS of chemicals presenting a delayed health hazard should be consulted for specific information on hazard controls and safety measures.

The following general control measures should be implemented whenever using or handling chemicals which pose a delayed health hazard:

- Plan experiments involving delayed health hazards carefully, including consulting the SDS(s). Do not handle chemicals that present delayed health hazards until all safety precautions have been read and understood.
- Minimize the quantity and/or concentration of these chemicals used or synthesized to the smallest amount immediately needed for an experiment.
- Design experimental procedures to minimize the potential for splash, splatter or other likely scenarios of accidental contact.
- Do not breathe dust, fumes, gas, mist, vapors or sprays when handling these chemicals.
- Wash hands thoroughly after handling.
- Do not bring contaminated work clothing out of the laboratory.

5. Engineering Controls

A certified chemical fume hood must be used when handling select carcinogens, respiratory sensitizers and target organ toxins (from prolonged or repeated exposure) through inhalation. Other containment devices may be used to control exposure to these chemicals, such as glove boxes. This is especially useful when manipulating the carcinogen in such a way that it volatilizes, generates aerosols, or may result in uncontrolled release of the chemical.

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory. Laboratory personnel working with carcinogens, skin sensitizers or target organ toxins (from prolonged or repeated exposure) should wear splash goggles instead of safety glasses. Double gloving with examination-type gloves, or the use of chemical resistant gloves, should be used if the compound can be readily absorbed through the skin. Refer to the Personal Protective Equipment Selection Guide on the RLSS website for further information on appropriate chemical-resistant gloves. Other personal protective equipment that should be considered include a face shield (for high splash hazards) and a chemical-resistant apron.

If respiratory sensitizers, carcinogens with an inhalation hazard, or target organ toxins (from prolonged or repeated exposure) cannot be used in a ventilated enclosure (i.e. chemical fume hood) or containment device (i.e. glove box) due to experimental restrictions, laboratory workers should consider the use of a respirator. Contact RLSS to perform a hazard assessment of your experimental procedures to determine if respiratory protection should be used. An RLSS hazard assessment report is required prior to registration into the Respiratory Protection Program, facilitated by Risk Management Services.

7. Handling and Storage Requirements

Segregate carcinogens from other hazardous chemicals and store within a labeled designated area. Ideally, this segregation would occur via separate cabinets. If space is limited, however, storing select carcinogens in secondary containment (i.e. plastic trays or Tupperware) within the same

cabinet as other chemicals is acceptable. Carcinogens should be securely stored, and access to these chemicals should be restricted.

Some chemicals within this hazard class may require exposure monitoring and routine medical surveillance for any laboratory personnel who may be exposed. RLSS will inform the AH/ASC if any chemicals used in the laboratory require such monitoring/medical surveillance.
Carefully plan the transportation of select carcinogens and target organ toxins. Handling chemicals outside of the laboratory area should be minimized, but when necessary, wear full personal protective equipment and carry the chemicals in unbreakable secondary containment.

8. Waste Disposal

Hazardous chemical waste that presents a delayed health hazard should be collected in compatible waste containers (i.e. plastic 3.5 gallon buckets) and segregated from incompatible chemicals. Some carcinogens may require special decontamination and disposal procedures. Contact Risk Management Services for further information on the disposal of chemicals.

9. Spill and Incident Procedures

Laboratory personnel may clean a small spill of chemicals that present a delayed health hazard themselves, as long as they wear appropriate personal protective equipment and have appropriate training. If the spill is large, requires a respirator for cleanup, or occurs in a public area, do not attempt to clean the spill yourself. Evacuate the area and follow the procedures in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.

If a laboratory worker is injured or exposed to chemicals that present a delayed health hazard, immediately notify the AH/ASC; call 911 if the laboratory worker needs immediate medical attention. Remove contaminated clothing and immediately flush the contaminated areas with water for at least 15 minutes. For eye exposures, immediately remove contact lenses, if present, and flush the eyes with water for at least 15 minutes.

If the exposure is less severe, and the laboratory worker is left feeling ill or if there is persistent discomfort, call the Arizona Poison & Drug Information Center at 1-800-222-1222 for information to determine if further medical action is required. Consult the chemical's SDS for more specific information on appropriate first aid. Inform RLSS and RMS of the incident as soon as practicable.

10. Designated Area

Carcinogens are considered to be particularly hazardous chemicals. Because of this, some chemicals in this hazard class will require the designation of an area for their use and storage. All laboratory workers must know the location of these designated areas, and must use or store particularly hazardous chemicals only within them. Designated areas also require posting with the "Designated Area Label," which can be found on the RLSS website.

B-11 Chemical Hazard Class SOP for Developmental & Reproductive Toxins

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely work with developmental and reproductive toxins in a University of Arizona (UA) laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before using developmental and reproductive toxins. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

This hazard class SOP only addresses safety issues specific to the developmental and reproductive toxicity of a chemical; several hazard class SOPs may be applicable for a specific chemical.

3. Hazard Description

This hazard class includes chemicals that affect the reproductive capabilities of a person, including mutations and effects on the fetus. The following hazard types are included in this SOP:

- Causes genetic defects
- May damage fertility or the unborn child
- May cause harm to breast-fed children

The first two hazard types listed above are split into two categories based on the severity of the hazard. Chemicals with the higher categories of developmental and reproductive toxicity are considered to be particularly hazardous chemicals, as defined by OSHA. However, it is important to note that not every chemical under this hazard class is a particularly hazardous chemical.

4. General Control of Hazards

The following general control measures should be implemented whenever using or handling chemicals which act as a developmental or reproductive toxin:

- Plan experiments involving developmental and reproductive toxins carefully, including consulting the SDS(s). Do not handle chemicals that present developmental and reproductive toxicity until all safety precautions have been read and understood.
- Minimize the quantity and/or concentration of these chemicals used or synthesized to the smallest amount immediately needed for an experiment.
- Design experimental procedures to minimize the potential for splash, splatter or other likely scenarios of accidental contact.
- Do not breathe dust, fumes, gas, mist, vapors or sprays when handling these chemicals.
- Wash hands thoroughly after handling.
- Do not bring contaminated work clothing out of the laboratory.

- Keep exposure to these chemicals as low as reasonably achievable while pregnant or nursing. For additional information on pregnancy and working with hazardous chemicals while pregnant, contact the Arizona Poison & Drug Information Center at 1-800-222-1222.

5. Engineering Controls

A certified chemical fume hood must be used when handling developmental and reproductive toxins. Other approved ventilated enclosures (e.g. glove box) may be used to control exposure to developmental and reproductive toxins. For additional information on engineering control options, contact RLSS or your AH/ASC.

6. Personal Protective Equipment

At a minimum, all laboratory workers must wear safety glasses, long pants, closed-toed shoes, a laboratory coat and examination gloves when working with hazardous chemicals in a laboratory. Laboratory personnel working with developmental or reproductive toxins should wear splash goggles instead of safety glasses. Double gloving with examination-type gloves, or the use of chemical resistant gloves, should be used if the compound can be readily absorbed through the skin. Refer to the Personal Protective Equipment Selection Guide on the RLSS website for further information on appropriate chemical-resistant gloves.

If developmental and reproductive toxins cannot be used in a ventilated enclosure (i.e. chemical fume hood) due to experimental restrictions, laboratory workers should consider the use of a respirator. Contact RLSS to perform a hazard assessment of your experimental procedures to determine if respiratory protection should be used. An RLSS hazard assessment report is required prior to registration into the Respiratory Protection Program, facilitated by Risk Management Services.

7. Handling and Storage Requirements

Segregate developmental and reproductive toxins from other hazardous chemicals. Ideally, this segregation would occur via separate cabinets. If space is limited, however, storing developmental and reproductive toxins in secondary containment (i.e. plastic trays or Tupperware) within the same cabinet as other chemicals is acceptable. Developmental and reproductive toxins must be securely stored, and access to these chemicals should be restricted. Those that are classified as particularly hazardous chemicals must be stored and used within a labelled designated area. If you are unsure if a developmental or reproductive toxin constitutes a particularly hazardous chemical, be conservative and treat them as if they are.

Some chemicals within this hazard class may require exposure monitoring and routine medical surveillance for any laboratory personnel who may be exposed. RLSS will inform the AH/ASC if any chemicals used in the laboratory require such monitoring/medical surveillance.
Carefully plan the transportation of developmental and reproductive toxins. Handling chemicals outside of the laboratory area should be minimized, but when necessary, wear full personal protective equipment and transport the chemicals in unbreakable secondary containment.

8. Waste Disposal

Hazardous chemical waste containing developmental and reproductive toxins should be collected in compatible waste containers (i.e. plastic 3.5-gallon buckets) and segregated from incompatible wastes. Some particularly hazardous chemicals may require special decontamination and disposal procedures. Contact Risk Management Services for further information on the disposal of chemicals.

9. Spill and Incident Procedures

Laboratory personnel may clean a small spill of developmental and reproductive toxins themselves, as long as they wear appropriate personal protective equipment and have appropriate training. If the spill is large, requires a respirator for cleanup, or occurs in a public area, do not attempt to clean the spill yourself. Evacuate the area and follow the procedures in the University Chemical Hygiene Plan section on major chemical spills. Inform RLSS of all major chemical spills.

If a laboratory worker is injured or exposed to developmental and reproductive toxins, immediately notify the AH/ASC; call 911 if the laboratory worker needs immediate medical attention. Remove contaminated clothing and immediately flush the contaminated areas with water for at least 15 minutes. For eye exposures, immediately remove contact lenses, if present, and flush the eyes with water for at least 15 minutes. Inform RLSS and RMS of the incident as soon as practicable.

If the exposure is less severe, and the laboratory worker is left feeling ill, persistent discomfort, or has concerns about potential developmental effects, they should call the Arizona Poison & Drug Information Center at 1-800-222-1222 to determine if further medical action is required. Consult the chemical's SDS for more specific information on appropriate first aid.

10. Designated Area

Chemicals that cause genetic defects or damage fertility or the unborn child are considered to be particularly hazardous chemicals. Because of this, some chemicals in this hazard class will require the designation of an area for their use and storage. All laboratory workers must know the location of these designated areas, and must use or store particularly hazardous chemicals only within them. Designated areas also require posting with the "Designated Area Label," which can be found on the RLSS website.

B-12 Proper Use of a Chemical Fume Hood Standard Operating Procedure

1. Purpose

This Standard Operating Procedure (SOP) defines proper work practices when using a chemical fume hood. When used correctly, a chemical fume hood can help prevent exposure to hazardous chemicals; when it is not used within its manufacturer specifications and parameters, it may not provide adequate protection against exposure. If you have any questions concerning the applicability of any item listed in this procedure, contact your Approval Holder (AH), Approval Safety Coordinator (ASC) or facility coordinator, or the Research Laboratory & Safety Services (RLSS).

2. Scope

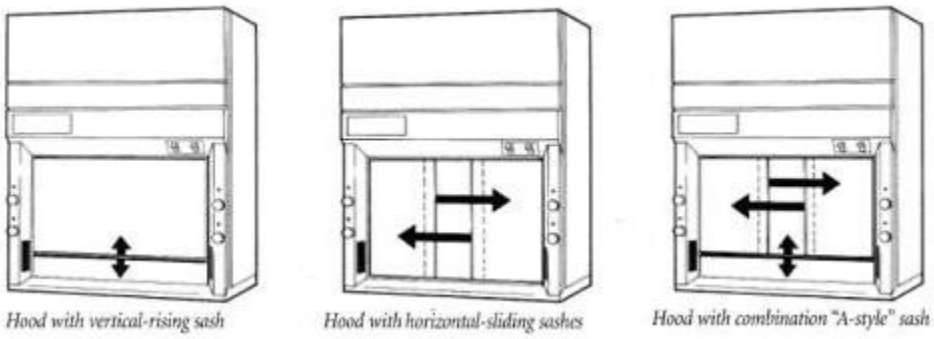
Ideally, chemical fume hoods should be used when working with any hazardous chemicals in the laboratory. A chemical fume hood must, however, be used whenever particularly hazardous chemicals (i.e. select carcinogens, developmental and reproductive toxins and chemicals with a high degree of acute toxicity) are being manipulated or when hazardous vapors, mists, aerosols or gases are being used or created during a procedure. A chemical fume hood may also be used for the storage of lecture bottle-sized cylinders of hazardous gases (e.g. gases with a National Fire Protection Agency [NFPA] health rating of 3 or 4).

3. Chemical Fume Hood Requirements

Chemical fume hoods must be used according to manufacturer specifications. Some hazardous chemicals may require the use of a specialized or modified chemical fume hood (e.g. perchloric acid). Do not modify the chemical fume hood from its manufactured settings (i.e. drilling holes into the cabinet, resetting blast gates, etc.) unless your specific modification has been assessed and approved by RLSS. Though manufacturer specifications may change slightly from hood to hood, some basic principles are the same and must be used in University laboratories.

- The fume hood must be certified annually by UA Facilities Management (FM) or a contracted vendor (i.e. for some satellite locations). A certification label must be present on the front of the fume hood, including the date of the last certification.
- The majority of chemical fume hoods should be functioning at a minimum of 100 linear feet per minute (fpm), though some high performance low-flow fume hoods also exist. Often, the certification label will include a mark for the fume hood sash height at which this minimum face velocity is reached. If you are unsure if a fume hood is functioning at an adequate face velocity, contact RLSS to perform face velocity measurements.
- When a highly toxic or corrosive gas is being stored in the chemical fume hood, the face velocity should be maintained at 200 fpm.
- The fume hood light, alarm and sash should be fully functional at all times.
- Chemical fume hoods should not be plumbed into publicly owned treatment works; those with sinks should be disconnected from the drain or guarded against accidental spills.

- There are two main types of chemical fume hoods: those with a vertical sliding sash and those with a horizontal sliding sash, as illustrated in Figure 1. Different certification and use procedures are necessary for each type of fume hood.
- Experiments or devices utilizing an open flame may not be performed in a fume hood, laminar flow hood or exhausted enclosure.



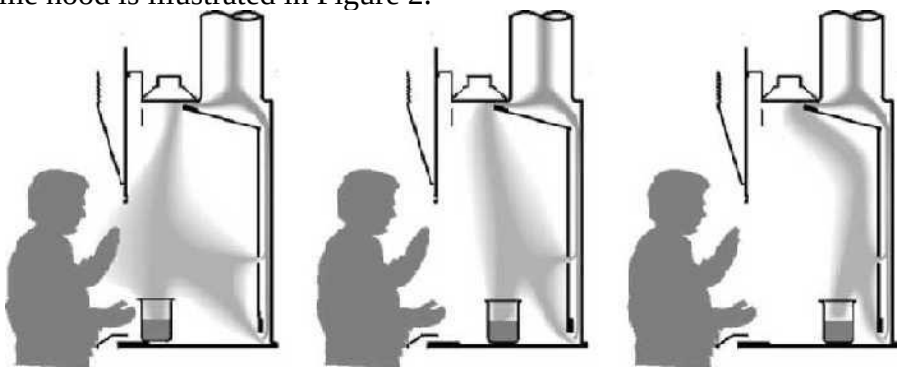
Labconco, Inc.

Figure 1: Illustration of the types of chemical fume hood sashes.

4. Proper Fume Hood Practices

Work must be performed with the sash at or below the mark at which the fume hood was certified. This level is typically identified by an arrow on the certification label or a line drawn in permanent marker. When working with a chemical fume hood with a vertical sliding sash, you should work with the sash at its lowest possible position, while still allowing for comfortable working conditions. When working with chemical fume hoods with horizontal sliding sashes, workers should work with their arms around a panel of the horizontal sash. If this is not possible or causes difficulties in performing experimental actions, modifications may be made by the manufacturer (e.g. narrowing the width of each horizontal sash panel) or other shielding methods may be used to allow for adequate protection. Contact RLSS for further information.

To allow adequate airflow and protection against hazardous fumes, mists, vapors, dusts, etc., all work must be performed at least 6 inches inside of the hood. Some chemical fume hoods have a stainless steel bar installed on the outside of the fume hood, which forces workers to stand 6 inches from the hazardous chemical work. Contact RLSS to obtain prior written approval for the removal of this bar if it prevents practical/safe work practices. The importance of working six inches within a chemical fume hood is illustrated in Figure 2.

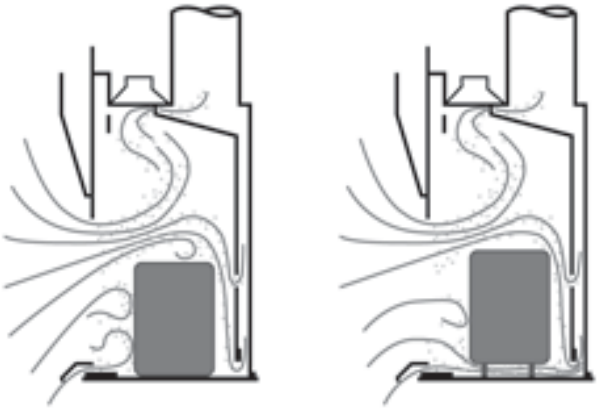


web.princeton.edu

Figure 2: Containment of vapors in a chemical fume hood as a function of working distance.

The fume hood sash should be lowered completely when it is not in use, especially during unattended reactions.

Do not store hazardous chemicals or other items inside of a chemical fume hood, unless they require ventilated storage. The more objects present in a chemical fume hood, the less effective the air flow is in protecting workers against hazardous chemicals. If items, such as hot plates, shaker tables or other equipment required for the reaction, must be placed in a chemical fume hood, place them on a stand to allow airflow underneath, as shown in Figure 3. Contact RLSS to verify the fume hood's performance after adding large objects or shielding into a hood, or if a degradation of normal airflow is suspected.



web.princeton.edu

Figure 3: Obstruction of air flow by objects in a chemical fume hood.

5. Malfunctioning/Uncertified Chemical Fume Hood

If the chemical fume hood alarm sounds, immediately discontinue work, close the fume hood sash and reset the alarm. Verify the alarm settings; if the fume hood alarm system is functioning properly (e.g. it is not set to a low face velocity such as 10 fpm), contact the Facilities Management HVAC group at 520-621-3000 to inform them of the alarm if you are on the main campus. If the fume hood is at a UA satellite location, inform your facility coordinator and facility ventilation contractor of the fume hood alarm.

If the chemical fume hood is not functioning properly (e.g. lighting malfunction, strange noises coming from the fume hood, face velocity is below 100 fpm, the sash will not move properly, etc.) or is overdue for recertification, contact the FM HVAC group (main campus) or your facility coordinator and facility ventilation contractor (satellite locations) to schedule maintenance of the chemical fume hood.

B-13 Standard Operating Procedure for the Use of Particularly Hazardous Drugs/Chemicals in Animals

1. Purpose

The purpose of this Standard Operating Procedure (SOP) is to describe the best practices for the identification, risk communication, and disposal of waste when using Particularly Hazardous Drugs/Chemicals in animals. Compliance with this SOP will protect workers and the environment from potential exposure to these chemical hazards. Exposure to hazardous and Particularly Hazardous Drugs/Chemicals (i.e. carcinogens, developmental & reproductive toxins, and highly/acutely toxic chemicals) may occur when substances are compounded, administered (e.g.

administered in the animal's drinking water or food), and/or when they or their toxic metabolites are released from the animal (e.g. in the urine, feces, exhalation, etc.). Therefore, hazardous and particularly hazardous drug/chemicals administration to live animals not only impacts the animal but also has the potential to affect researchers and University's Animal Care (UAC) staff handling these animals and their waste. Researchers must inform UAC before using any new hazardous chemicals (to include and Particularly Hazardous Drugs/Chemicals) in animals.

2. Scope

The use of any of the drugs/chemicals listed within the National Institute for Occupational Safety and Health (NIOSH) "List of Antineoplastic and Other Hazardous Drugs (2016)" in animals falls under the purview of this SOP. RLSS performs a protocol-specific assessment for all submitted IACUC protocols to classify any Particularly Hazardous Drugs/Chemicals not identified on the NIOSH list. Similar assessments will also be performed to determine requirements for particularly hazardous drugs/chemicals administered to large animals. Updated or amended protocols must be re-assessed by RLSS prior to the implementation of any changes.

This SOP addresses the hazards of these drugs/chemicals during and after administration only. Refer to the University Chemical Hygiene Plan on the RLSS website for information on how to safely handle particularly hazardous chemicals in their pure form.

3. Hazard Classification

Particularly Hazardous Drugs/Chemicals can pose the following hazards either during administration to animals or after they have been administered to the animal:

3.1 Injection Hazard: Accidental needle sticks when administering compounds to animals can allow particularly hazardous drugs/chemicals to directly enter the bloodstream.

3.2 Dermal Hazard: Handling animals that have been administered creams/ointments and/or handling contaminated bedding can allow Particularly Hazardous Drugs /Chemicals to be absorbed through the skin when personal protective equipment is not used and/or not properly used.

3.3 Inhalation Hazard: Particularly hazardous drugs/chemicals or their toxic metabolites that are excreted and/or exhaled from the animal pose an inhalation hazard.

3.3.1 Bedding Dust Hazard: These are particularly hazardous drugs/chemicals and/or their toxic metabolites that are excreted via the animal's urine, released into the bedding from contaminated drinking water, or otherwise adsorbed onto bedding particles and which pose a particulate inhalation exposure risk. Dumping contaminated cage bedding can generate particulates with adsorbed toxic compounds.

3.3.2 Animal Exhalation Hazard: Particularly hazardous drugs/chemicals or their toxic metabolites that are exhaled from the animal and pose an inhalation hazard to the workers when opening cages, changing bedding, or otherwise working with animals post-administration. Please contact RLSS for calculated exposure estimates for animals administered with drugs/chemicals that can post exhalation hazards.

3.4 Resource Conservation and Recovery Act (RCRA) Chemicals : The waste from animals that have been administered heavy metal-containing particularly hazardous drugs/chemicals require special disposal procedures detailed below. Compounds containing any of the following metals fall directly under RCRA and must follow the special disposal requirements:

- Mercury
- Arsenic
- Lead
- Silver
- Barium
- Selenium
- Cadmium
- Chromium

Table 1: RCRA Waste Determinations shows common concentration limits for RCRA Waste Determination. Concentrations in or above these values are considered part of the RCRA regulatory requirement and therefore need special disposal requirements.

Table 1: Common RCRA Waste Determinations

RCRA Waste
Mercury (≥ 0.2 mg/L)
Cadmium (≥ 1 mg/L)
Selenium (≥ 1 mg/L)
Arsenic (≥ 5 mg/L)
Chromium (≥ 5 mg/L)
Lead (≥ 5 mg/L)
Silver (≥ 5 mg/L)
Barium (≥ 100 mg/L)

All RCRA waste must be tracked using a log. More information about this log can be found in the Exposure control section and the Appendix B section of this document.

4. Exposure Control

All researchers using hazardous chemicals in animals must follow the steps below to prevent exposure to particularly hazardous drugs/chemicals.

4.1 Program Registration: The use of any hazardous chemicals in a laboratory setting requires registration into the Laboratory Chemical Safety Program (LCSP). Principal investigators who are new or have not previously registered can register by contacting RLSS at rlss-chem-support@email.arizona.edu.

4.2 Hazard Identification: Inform RLSS of any planned use of hazardous chemicals in research animals. This is typically accomplished through the submission of an IACUC application. RLSS will inform researchers and UAC of any proposed drugs/chemicals that are classified as particularly hazardous. RLSS will work with researchers to ensure appropriate protective measures are in place during animal protocols, including choosing the appropriate housing to protect against inhalation hazards.

4.3 Informing UAC: Inform UAC of your use of particularly hazardous drugs/chemicals in animals; this must be completed by utilizing the Hazard Cage Card. RLSS will work with researchers and UAC staff to ensure appropriate protective measures are in place during animal protocols, including choosing the appropriate housing to protect against inhalation hazards.

4.4 Hazard Cage Card: Researchers must complete the Hazard Cage Card (example included as Appendix A) for each cage housing animals that will be administered particularly hazardous drugs/chemicals according to the hazard identification performed by RLSS and the training provided by UAC. This is required, at minimum, from the time of first dose to 72-hours after the last dose was administered to the animal(s). If animals (e.g. mice and rodents) are caged outside of UAC facilities, Hazard Cage Cards must be used in all situations and at all times to properly communicate potential hazards. It is the researcher's responsibility to remove the card 72-hours after the last drug administration.

4.5 Personal Protective Equipment: The researcher must wear appropriate Personal Protective Equipment (PPE) when handling particularly hazardous drugs/chemicals and/or when administering drugs/chemicals to animals:

- Double disposable nitrile gloves
- Lab coats and/or disposable gowns
- Splash goggles (preferred) or safety glasses (minimum)
- Long pants
- Close-toed shoes

Additional PPE may be required and could include puncture-resistant gloves, face shields, and/or respirators. RLSS should be contacted and consulted prior to the

implementation of additional/elevated PPE, as there may be additional training and/or requirements (e.g. participation in the UA Respiratory Protection Program).

4.6 Particularly Hazardous Drug/Chemical Administration: The administration of particularly hazardous drugs/chemicals via inhalation (or in any manner that creates a potential inhalation hazard) must be performed in a chemical fume hood or other approved ventilated enclosure (e.g. fully exhausted, interlocked biosafety cabinets) that are labeled with the "Designated Area" label available on the RLSS website. Contact RLSS prior to administration to ensure appropriate ventilation is being utilized.

When particularly hazardous drugs and chemicals are administered by injection, syringes and IV sets must include Luer (lock preferred over slip-type) fittings to avoid potential injection hazards.

4.7 Waste Disposal: After most particularly hazardous drugs/chemicals have been administered to an animal, the resulting waste (i.e. used bedding, disposable cages, etc.) may be disposed of as general non-hazardous waste for landfill disposal. Some exceptions exist to this rule. For example, any particularly hazardous drug/chemical waste containing biohazardous material or unfixed animal tissue/blood must be disposed as biohazardous waste. In addition, particularly hazardous drugs/chemicals containing heavy metals fall under RCRA requirements. Researchers generating RCRA waste must use the Waste Container Content Log (seen Appendix B) to track the amount of heavy metals being added within the specific container from each protocol. This log will be used to complete Risk Management Services waste tags before requesting waste collection.

4.7.1 Dumping Animal Bedding: Dumping or otherwise manipulating the bedding (such as taking empty caging to dirty-side cage wash) that housed animals (e.g. mice and rodents) administered a particularly hazardous drug/chemical must be performed in a chemical fume hood or another approved ventilated enclosure such as a biosafety cabinet or HEPA-filtered change station. To allow for full excretion of the drugs/chemicals, these special procedures must be followed for any bedding dumping between the administration "Start Date" and 72 hours after the "End Date" noted on the Hazardous Materials Cage Card. Approved ventilated enclosures vary dependent upon the chemical the animal has been dosed with prior to excretion; please work with RLSS to determine the appropriate ventilated enclosure.

Chemicals classified as "Bedding Dust Hazards" should be dumped in a non-recirculating ventilated enclosure such as a chemical fume hood. If a fume hood or other non-recirculating ventilated enclosure is unavailable, however, they are permitted to be dumped in ventilated enclosures that have high efficiency filters such as an A2 BSC, HEPA-filtered change station, or other RLSS approved enclosure.

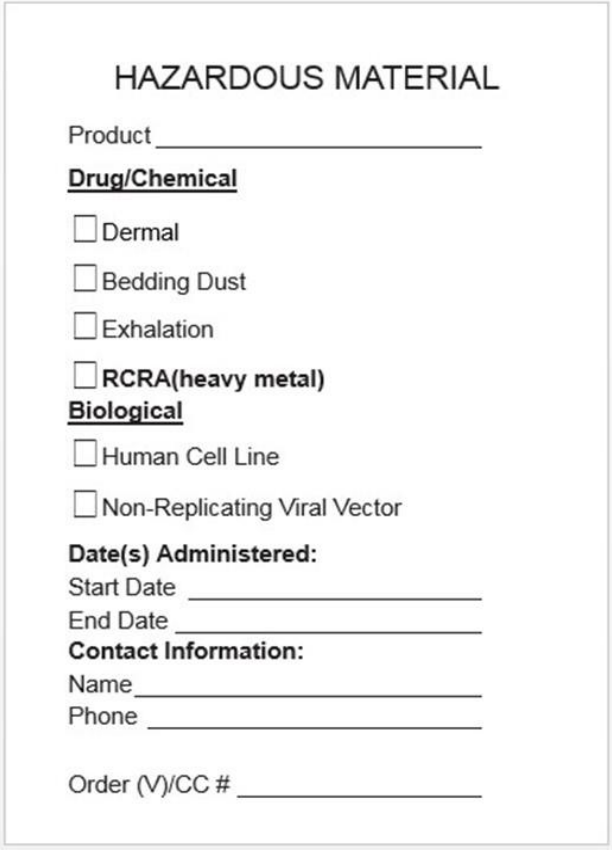
Chemicals classified as "Animal Exhalation Hazards" require the use of a non-recirculating ventilated enclosure, such as hard-ducted Type II/B2 Biosafety Cabinet (BSC), chemical fume hood, or other RLSS approved enclosure. These

chemicals include azoxymethane (AOM), carbon tetrachloride, and others as communicated by RLSS.

Exceptions to these rules, such as for large animals like pigs, sheep, and more. Please work directly with RLSS to assess these situations on a case by case basis and ensure the continued safety of research and UAC staff members.

RLSS will inform the researcher and UAC when specific compound waste cannot be disposed of in a landfill. Consult with the Hazardous Waste Supervisor from Risk Management Services (RMS) (hazmat@arizona.edu) if you have any questions or concerns regarding the disposal of RCRA classified materials.

Appendix A – UAC Hazardous Material Cage Card



HAZARDOUS MATERIAL

Product _____

Drug/Chemical

☐ Dermal

☐ Bedding Dust

☐ Exhalation

☐ **RCRA(heavy metal)**

Biological

☐ Human Cell Line

☐ Non-Replicating Viral Vector

Date(s) Administered:

Start Date _____

End Date _____

Contact Information:

Name_____

Phone _____

Order (V)/CC # _____

Instructions:
Obtain a Hazardous Materials Cage Cards from UAC husbandry staff. Follow their instructions on how
to complete each section and how to post them on the appropriate animal cages.

Appendix B- Example RCRA Drug/Chemical Waste Container Content Log

RCRA Drug / Chemical Sharps / Solid / Liquid Waste Container Log *Circle waste form*				
Date	**P.I. Name**	**Drug/ Chemical Name**	**Waste Description (e.g. bedding, food, etc.)**	**Estimated Volume of Waste**
1/7/2020	Dr. Wilbur Wildcat	Sodium Arsenite	Bedding	1 kg

Instructions: Download the "**RCRA Particularly Hazardous Drug-Compound Waste Container Content Log"** from the **RLSS website.** Circle the physical form of the waste at the top of the page and attach one of these Content Logs to each waste container containing RCRA waste compounds/drugs.
Complete the log as shown in the example above every time the RCRA drug/chemical is added to the waste container, following the information in Section 4.8. This information is vital to the proper labeling of an RMS tag for collection of the RCRA waste.

B-14 Use of Hazardous Gases Standard Operating Procedure

1. Purpose

This standard operating procedure (SOP) details the requirements for ordering, storing, using, and disposing of **toxic, highly toxic, pyrophoric, corrosive, or commonly abused gases.** These will be referred to as hazardous gases for the remainder of this SOP.

2. Scope

Laboratories must be registered with and obtain approval from Research Laboratory & Safety Services (RLSS), before ordering, acquiring, and/or using the gases detailed in the following section. These gases have the potential to endanger people or property in the case of an accidental release and are therefore heavily controlled. The guidance provided in this document is highly generalized, and there may be additional or different requirements for each gas dependent upon the specific research objective/design. It is for this reason that RLSS must review all orders and authorize the use of these gases in UA laboratories. After registration and order approval, the safe use and storage of hazardous gases will be reviewed during routine safety inspections.

3. Hazardous Gases

The gases listed in Tables 1 are considered hazardous gases in accordance with this SOP and require prior approval by RLSS before ordering and delivering to laboratories. These examples are not all inclusive; other gases may be added depending on the hazards presented by their storage or use.

Table 1. Corrosive, toxic, highly toxic, toxic gases with poor warning properties, reproductive toxins, pyrophoric compressed gases, and compressed gases which are known carcinogens.

Compressed Gas	Chemical Formula	Corrosive	Toxic	Highly Toxic	Reproductive Toxin	Toxic with Poor Warning Properties	Pyrophoric	Carcinogenic
Ammonia	NH_3	X						
Arsine	AsH_3			X		X		X
1-3- Butadiene	C4H6				X			X
Boron trichloride	BCl_3	X						
Boron trifluoride	BF_3	X						
Carbon monoxide	CO				X	X		
Carbonyl fluoride	CF_2O	X	X					
Carbonyl sulfide	COS	X	X					
Chlorine	Cl_2	X	X					
Cyanogen	$(CN)_2$		X					
Cyanogen chloride	ClCN			X		X		
Deuterium chloride	DCl	X	X					
Diborane	B2H6			X			X	
Dichlorosilane	SiH_2CL_2						X	
Dimethylamine	C_2H_7N		X					
Ethylene oxide	C_2H_4O				X	X		X
Fluorine, ≥1%	Fl_2			X				
Germane	GeH_4			X			X	
Hydrogen bromide	HBr	X						
Hydrogen chloride	HCl	X						
Hydrogen cyanide	HCN			X				
Hydrogen fluoride	HF			X				
Hydrogen selenide	H_2Se			X			X	
Hydrogen sulfide	H_2S					X		
Methyl bromide	CH_3Br					X		
Methyl mercaptan	CH_4S	X	X					
Monomethylamine	CH_3NH_2	X						

Compressed Gas	Chemical Formula	Corrosive	Toxic	Highly Toxic	Reproductive Toxin	Toxic with Poor Warning Properties	Pyrophoric	Carcinogenic
Nitric oxide	NO			X		X		
Nitrous oxide *	N_2O							
Nitrosyl chloride	NOCl	X	X					
Phosgene	$COCl_2$			X		X		
Phosphine	PH_3			X			X	
Phosphorus pentafluoride	F_5P	X						
Selenium hexafluoride	SeF_6	X	X					
Silane, ≥1.37%	SiH_4						X	
Silicon tetrafluoride	SiF_4	X	X					
Stibine	SbH_3			X		X	X	
Sulfur dioxide	SO_2	X						
Sulfuryl fluoride	F_2O_2S					X		
Trimethylamine	C_3H_9N	X						
Vinyl chloride	C_2H_3Cl					X		X

*Oxidizing

4. Order and Delivery

To begin the order process of a hazardous gas, complete and submit the Hazardous Gas Order Request on the RLSS website. This form **must** be completed for all orders, whether initial, reorders, and/or orders of backup cylinders. After receipt of the request, RLSS will assess the hazards presented by the gas, as well as the control measures available in the laboratory. Assessments usually include a visit to the laboratory, though re-orders may only require a phone call to ensure equipment and processes have not changed. RLSS may request the assistance of technical experts (i.e. University Fire Marshall, hazardous gas experts, etc.) in these assessments. After RLSS assessment, all hazardous gases **must** be ordered through the University's Cryogenics & Compressed Gas Facility (UA Cryo), in the smallest practical quantity, and lowest concentration for its intended application. Gas cylinders must be ordered with restricted flow orifices, whenever possible. **Their use, storage, and disposal must be in accordance with any and all relevant regulations and/or applicable industry standards (e.g. Compressed Gas Association Standards and guidelines).**

After assessment, RLSS will approve, conditionally approve*, or disapprove each request in a formal, written letter to the laboratory and UA Cryo.

*May authorize the order but not the delivery of a gas until corrective measures have been resolved

5. Quantity Limits

Regulatory quantity limits often apply to these gases. These limits may be applicable to the lab itself, a storage unit, the floor of a building, or the entire building itself.

5.1 Building Quantity Limits: The University of Arizona adheres to the International Fire Code (IFC), which limits the quantities of hazardous gases allowed per building by "control areas." A control area is generally considered to be the floor of a building, though it can be a smaller area within a building floor.

During the order assessment process, RLSS will ensure that the desired hazardous gas order will not exceed the building's IFC storage and/or use limits. The IFC quantity limits for hazardous gases are summarized in Table 2. These quantities may vary if the building meets certain requirements; RLSS and the University Fire Marshall must be consulted for these unique situations.

Table 2. International Fire Code (IFC) Hazardous Gas Quantity Limits*

Material	Storage (standard cubic feet)	Use-Closed System (standard cubic feet)
Flammable Gas	1000	1000
Oxidizing Gas	1500	1500
Pyrophoric Gas	50	10
Unstable (Reactive) Gas	10 – 250	10 - 250
Corrosive Gas	810	810
Highly Toxic Gas	20	20
Toxic Gas	810	810

*Limits are based on cylinder **maximum internal water volume**, as per the IFC.

5.2 Storage Unit Limits: In addition to the IFC limits, the National Fire Protection Agency (NFPA) limits the amount of gases with an NFPA Health Rating of 3 or 4 that may be stored in a chemical fume hood. The following rules should be adhered to when storing such gases.

- Gases with a health rating of 3 or 4 in lecture bottles may be stored in a certified chemical fume hood.
- Gases with a health rating of 3 or 4 in gas cylinders larger than a lecture bottle should be stored in a certified gas cabinet, not a chemical fume hood.

6. Gas Cylinder Storage and Transport

6.1 Storage:

- Incompatible gases (e.g. oxygen and acetylene) must be separated by a distance of ≥20 feet, or a noncombustible partition extending ≥18 inches above and to the sides of the cylinders. Gases that are incompatible must not be stored within the same gas cabinet, fume hood, or exhausted enclosure. The room in which hazardous gases are stored must be ventilated and at negative pressure to any public areas.
- Hazardous gases must be stored in an approved, ventilated device such as a gas cabinet or chemical fume hood that are fitted with an alarm-installed airflow monitoring device. Some medical or research devices that require hazardous gases (e.g. optical lasers) are not ventilated but are manufactured to prevent exposure; these are also acceptable for the storage of hazardous gases upon a case-by-case approval by RLSS. Specific requirements exist for each type of storage device, unless otherwise noted by RLSS.
    - Gas cabinets must:
        - Be constructed of ≥12-gauge steel,
        - Connect to a local exhaust system,
        - Operate at a negative pressure in relation to surrounding areas,
        - Function with an average face velocity of ≥200 linear feet per minute (fpm), with ≥150 fpm at any point,
        - Have self-closing doors, limited access ports, and/or non-combustible windows to give access to equipment controls, and
        - Pass the gas through filters/scrubbers before releasing it out of the cabinet.
    - Chemical fume hoods must:
        - Operate at a negative pressure in relation to surrounding areas, and
        - Function with an average face velocity of ≥200 fpm, with ≥150 fpm at any point.
    - Approved medical/research devices must:
        - Conform to all manufacturer specifications unless modifications are approved by RLSS,
        - Utilize appropriate control measures (i.e. ventilation, scrubbers, filters, etc.),
        - Be controlled by a manual or automatic emergency failsafe, and
        - Be used in accordance to the setup, maintenance, and operational protocols developed by the laboratory and approved by RLSS.

If gases with a NFPA health rating of 3 or 4 in a cylinder larger than a lecture bottle must be stored in a chemical fume hood, the following additional control measures are required:

- Gas monitors must be affixed to the chemical fume hood to monitor ambient air concentrations of the hazardous gas and alarm at hazardous concentrations.
- The gas piping must have readily accessible manual or automatic fail-safe emergency shutoff valves installed at the point of use and the source (e.g. the cylinder).

Hazardous gas ventilated devices are certified annually by Facilities Management. RLSS can perform function checks but the responsibility to certify and/or repair devices that do not meet the criteria detailed in this SOP lies with Facilities Management.

6.2 Transport: RLSS does not recommend the transport of any hazardous gas cylinders by laboratory workers. Contact RLSS and Risk Management Services (RMS) if transport within a building, across campus, and/or to a secondary location is required to ensure workers are compliant with DOT regulations and all relevant safety requirements.

7. Piping, Tubing, Valves and Fittings

The piping, tubing, valves, and fittings used to carry a hazardous gas must be made of adequate strength and durability, and of material compatible with the gas itself. The piping system must not be located within corridors, within any route of egress, or within a concealed space. Connections between segments must either be welded or brazed unless the connections are within a ventilated enclosure or other safety measures have been approved by RLSS. The following requirements also apply to any piping, tubing, valves, and fittings carrying hazardous gases.

- Piping must be labeled to identify the hazardous gas being carried and the direction of flow.
- Piping, tubing, valves, and fittings must have backflow-prevention or check valves when the backflow of hazardous materials could create a hazardous condition (e.g. acetylene, hydrogen).
- Excess flow control must be provided within the ventilated enclosure if the hazardous gas is carried in the piping at >15 pounds per square in gauge (psig).
- If the gas piping is made of low melting point materials (i.e. aluminum, copper, some brass alloys, or non-metallic materials), they shall be:
    - protected by isolation from fire exposure by fire-resistive construction,
    - isolated from fire exposure by gas cabinets,
    - protected from fire exposure by an automatic fire-extinguishing system,
    - located so that any release resulting from failure of the piping systems will not unduly expose persons, buildings or structures, or
    - provided with a readily accessible shutoff valve or valves which will shut off the source of gas to the piping system in the event of leakage.

8. Release and Disposal

Highly toxic, toxic, and corrosive gases must be trapped, neutralized, or condensed to avoid contaminating vacuum pumps or discharging substantial quantities to exhaust air. Report any unplanned discharge/release of hazardous gases to RLSS at 520-626-6850 and Risk Management Services at 520-621-1790.
Hazardous gases may be purchased in returnable cylinders; these are cylinders larger than a lecture bottles (>1 L typically). Disposal or returns of these cylinders to the manufacturer should be coordinated through the UA Cryo**.**

Lecture bottles of gases are not returnable and must be collected by Risk Management Services for disposal. Prior to the removal of lecture bottles, researchers are required to complete the "**Stericycle Lecture Bottle Disposal Form**" that is available on the RLSS website AND provide a full-length photo for each lecture bottle of gas that will disposed. Please submit the form(s) and

photo(s) to RLSS (rlss-chem-support@arizona.edu) and RMS (hazmat@arizona.edu) to initiate the disposal process.

9. Equipment Maintenance

Equipment, machinery, and instruments associated with hazardous gases must be maintained in operable condition; SOPs should describe required maintenance (e.g. cleanings, filter replacements, etc.). Broken equipment, malfunctioning apparatus, or ventilated equipment out of certification must be immediately removed from service until it is replaced, repaired, or recertified. Contact Facilities Management for repairs and recertification. Ventilated equipment, piping, and other systems related to the storage and use of toxic or corrosive gases must not be modified without approval by RLSS.

10. Training and Hazard Communication

Beyond the OSHA and RLSS required trainings for hazardous chemical workers, laboratory personnel working with hazardous gases must be familiar with the hazards of the gas, proper handling procedures and emergency procedures detailed within the gas's Safety Data Sheet (SDS) **RLSS also requires the development of an SOP for all hazardous gases, to be included in the Laboratory Chemical Hygiene Plan (LCHP) that will be made available to all workers via the RLSS User Dashboard; please see the RLSS website for an SOP template. RLSS will work with each lab to develop the laboratory's hazardous gas SOP.** General safety information regarding the hazardous gas use and storage areas should be included in the Approval's Laboratory-Specific Training for hazardous chemical workers that do not use the hazardous gas.

Every cylinder of hazardous gas in possession must be entered into the Approval's hazardous chemical inventory within the RLSS User Dashboard. An SDS will be available to all laboratory workers from the RLSS User Dashboard for any hazardous gas entered into this inventory. Laboratory personnel should be aware of the location of the SDSs and refer to a gas's SDS before use. Individual gas cylinders must also be labeled with the name of the gas, the manufacturer name and address, and a GHS-compliant label warning of the gas's main hazard (e.g. Toxic, Corrosive, etc.).

11. Definitions

CGA: Compressed Gas Association

Corrosive Gas: A gas that can cause visible destruction of, or irreversible alterations in, living tissue (e.g., skin, eyes, or respiratory system) by chemical action.

Compressed Gas:

(i) A gas or mixture of gases in a container, having an absolute pressure exceeding 40 psi at 70 0 F (21.10 C) or

(ii) A gas or mixture of gases in a container, having an absolute pressure exceeding 104 psi at 130 0 F (54.40 C) regardless of the pressure at 70 0 F (21.1 0 C) or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 0 F (37.8 0 C) as determined by ASTM D-323-72.

DOT: U.S. Department of Transportation.

Flammable Gas: A gas that, at ambient temperatures and pressures, forms a flammable mixture with air at a concentration of less than thirteen (13) percent by volume; or forms a range of flammable mixtures with air wider than twelve (12) percent by volume.

Flammable limits: The concentration of flammable vapor in air, oxygen, or other oxidants that will propagate flame upon contact when provided with a source of ignition. The lower explosive limit (LEL) is the concentration below which a flame will not propagate; the upper explosive limit (UEL) is the concentration above which a flame will not propagate. A change in temperature or pressure may vary the flammable limits.

Flashpoint: The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite and sustain a flame.

Hazardous Gas: A gas that is included in one or more of the following hazard categories: corrosive, flammable, health hazard, oxidizer, pyrophoric, reactive, or toxic.

Health Hazard: Any chemical for which there is at least one scientific study that shows it may cause acute or chronic health symptoms. This includes chemicals which are carcinogens, toxic or highly toxic, irritants, corrosives, sensitizers, or chemicals that effect target organs including the lungs, kidneys, nervous system, pulmonary system, reproductive system, skin, and/or eyes.

Ignition Source: Anything that provides heat, sparks, or flame sufficient to cause combustion/explosion.

Incompatible: Materials which could cause dangerous reactions from direct contact with one another.

LEL: (Lower Explosive Limit) LEL is the lowest concentration of a gas or vapor in the air that can produce ignition or explosion. Mass Flow Controller- (MFC) is a device used to measure and control the flow of gases.

SDS: (Safety Data Sheet) Written or printed material about a chemical that specifies its hazards, safe use and other information. It is prepared by the chemical manufacturer, and is required by federal law.

NFPA: National Fire Protection Association.

NFPA Health Rating 3: Materials that can affect health or cause serious injury, during periods of short exposure, even though prompt medical treatment is give; this can be determined using a chemical's SDS.

NFPA Health Rating 4: Materials that can affect health or cause serious injury, during periods of very short exposure, even though prompt medical treatment is given; this can be determined using a chemical's SDS.

Oxidizing gas: A gas that initiates or promotes combustion in materials, either by catching fire itself or by potentially causing a fire through the release of oxygen or other gases.

Oxygen deficiency: A condition that occurs when a breathable atmosphere contains less than 19.5% oxygen. Note: Normal air contains 20.8% oxygen.

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

Pyrophoric gases: Gases that may spontaneously ignite in air at or below 54 ºC (130 ºF). Specific gases may not ignite in all circumstances or may explosively decompose.

Restrictive Flow Orifice (RFO): A safety device placed in the outlet of a cylinder valve that is intended to limit the release rate of a hazardous gas to a maximum specified range in the event of the inadvertent opening of the valve, or failure of the system downstream of the valve outlet.

STP: Standard Temperature and Pressure or STP is defined as 0 °C (32 °F) and 1 atmosphere of pressure (101.325 kPa or 29.92 inHg).

Toxic gas: A gas that is poisonous or capable of causing injury or death, especially by chemical means, at room temperature and has:

(i) a median lethal dose (LD(50)) of 50 mg or less per kg of body weight when administered orally to albino rats weighing between 200 and 300 grams each; or

(ii) a median LD(50) of 200 mg/kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each; or

(iii) a median lethal concentration (LC(50)) in air of 200 PPM by volume or less when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

UEL: Upper Explosive Limit - The highest concentration of a gas or vapor in air that can produce ignition or explosion.

Unstable (Reactive): An unstable or reactive chemical can go through vigorous polymerization, decomposition or condensation. This process occurs when the chemical

B-15 Unattended Reaction Standard Operating Procedure

1. Purpose

This Standard Operating Procedure (SOP) defines the general requirements for conducting unattended reactions. It includes specifications for the setup, hazard communication and monitoring of unattended reactions in the laboratory. If you have questions concerning the requirements within this SOP, contact the Approval Holder (AH)/Approval Safety Coordinator (ASC), or the Research Laboratory & Safety Services (RLSS).

2. Scope

An unattended reaction is any reaction (i.e. chemical, biological, biochemical) that is initiated by a researcher and then left unattended for a period of time. A reaction may be left unattended for one or multiple hours, overnight or for multiple days. Examples of unattended reactions include organic and inorganic syntheses, DNA extractions, as well as automated processes.

3. Hazard Description

Multiple hazards can be presented by an unattended reaction, depending on the starting materials used, reaction conditions and the reactivity of any potential products. Without the person who initiated the reaction present, other laboratory workers cannot know the hazards of the reaction. If an unattended reaction is not monitored, certain methods and reaction conditions (e.g. heating, grinding, stirring, cooling, etc.) may pose a greater risk to surrounding laboratory workers, as well as laboratory equipment.

4. Unattended Reaction Setup

Any unattended reactions involving hazardous chemicals must be set up within a certified chemical fume hood or other approved ventilated enclosure (e.g. Biosafety Cabinet Type II B2, glove box, etc.). The sash of the chemical fume hood must be adjusted to its lowest possible position and the reaction apparatus must be moved as far back in the chemical fume hood (or other ventilated enclosure) as is reasonable when the reaction is unattended. The area immediately surrounding the unattended reaction should be free of clutter.

Refrain from heating a reaction while it is left unattended whenever possible. If heating is necessary, the temperature must be monitored and controlled by a thermometer or other thermal sensing device. The built-in thermometer of a hot plate is not appropriate for this purpose. Oil baths that must be left unattended should be fitted with a thermal sensing device that turns off the electric power if the bath overheats and exceeds a set limit. Remove combustible or flammable substances from the area when the reaction is heated.

If your reaction may cause an increase in pressure within the reaction vessel, the reaction must be properly ventilated to avoid an explosion and projection hazard. In some instances, shielding may

be necessary to prevent these projection hazards. This may be accomplished using the fume hood sash or a portable blast shield that is placed between the reaction and the laboratory work area.

5. Hazard Communication

Obtain permission from your AH/ASC before beginning a reaction that must be left unattended. The reaction vessel must be labeled, either with the components of the reaction, or with a page number of a laboratory notebook that fully describes the reaction. If the latter is chosen, the laboratory notebook must be available near the reaction while it is left unattended.

Laboratory workers must complete the Unattended Reaction Form (available on the RLSS website) for every unattended reaction. The completed form must be placed in a visible location in front of the reaction apparatus (e.g. on the chemical fume hood sash) before the reaction is left unattended. It is vital that the person initiating the reaction leaves an accessible phone number on this form so first responders and agencies may have a point of contact in case of an emergency involving the unattended reaction. If a laboratory worker plans on performing many different unattended reactions throughout the year, they may want to consider laminating the Unattended Reaction Form and using a dry erase marker to fill out the form for each reaction.

6. Unattended Reaction Monitoring

Experimental protocols for unattended reactions must include periodic monitoring of the reaction throughout the reaction process. This is to ensure the reaction is proceeding as planned and further hazards are not being created (e.g. flammable solvents boiling over when heated or catching on fire, corrosive liquids corroding the septum, etc.). If a reaction is being performed over multiple days, it must be monitored at least once a day.

7. Emergency Procedures

Before you begin a reaction that will be left unattended, you must consider what emergency situations could be caused by the reaction and what signs of such emergencies may exist (e.g. smoke issuing from reaction, creation of sparks, fire, etc.). Explain these warning signs and the steps that must be taken in the case of an emergency in the “Emergency Warning Signs” section of the Unattended Reaction Form.

Properly completing these sections of the Unattended Reaction Form will help laboratory workers or other personnel recognize and respond to an emergency situation caused by an unattended reaction. The proper response in such situations could mean the difference between a small accident and an incident causing harm to fellow workers or damage to equipment.

B-16 Use of Controlled Substances for Research Standard Operating Procedure

1. Purpose

This standard operating procedure (SOP) details the requirements for obtaining a registration and for ordering, storing, using, and disposing of Drug Enforcement Agency (DEA) Controlled Substances (CS). These will be referred to as DEA CS for the remainder of this SOP.

2. Scope

The use of controlled substances (Schedule I - V drugs) in research laboratory operations (including research animals) is subject to all relevant state and federal regulatory requirements. Under controlled substances regulations (21 CFR §1308), Principal Investigators(PI)/Approval Holders (AH) must obtain a **Form DEA-225 "Researcher" Registration*** from the federal DEA. Research Laboratory & Safety Services (RLSS) has worked with local DEA agents to streamline applications and paperwork procedures, as outlined below; **you must contact RLSS prior to completing your registration application for a consultation (primer on the regulations, recordkeeping, etc.) and information to receive a fee exemption**. UA will not pay any fines or damages resulting from noncompliance with federal, state, and local regulations, or resulting from noncompliance with university policies; such fines or damages are the sole responsibility of the registered individual.

*Medical and veterinary doctors (MD, MD/PhD, DVM) should note that these requirements are separate from and in addition to any that apply to licensing for clinical prescriptions and patient dispensing. Clinical and/or veterinary DEA registration cannot be used for research purposes.

3. Registration

Faculty members and limited staff members who order, store, use, and dispose of DEA CS must register with the DEA (for Schedules I-V); to be a Registrant, the individual must have oversight of the research on a protocol and be able to demonstrate the legitimacy of their research credentials (e.g. PhD or extensive research credentials).

- State Registration: Arizona does **not** have a state registration, unlike many other states. Contact RLSS and the local (Tucson) DEA office for assistance if you are transferring your DEA CS and registration to Arizona from another state.
- Federal Registration: **Contact RLSS prior to completing your federal DEA application for a consultation (primer on the regulations, recordkeeping, etc.) to receive a fee exemption**. Federal registration can be completed online at the DEA website, or via mail. Researchers must use the Form DEA-225 "Researcher" registration.
    - DEA registrations must be renewed annually; the DEA will contact you the month prior to expiration for a renewal.
    - RLSS has a Standard Operating Procedure template that should be filled out at the time of registration application; once the DEA has reviewed your application,

they will request the information contained in the SOP. The applicant can simply return their current CV and a copy of the SOP to satisfy these requirements.

- For modifications*, transfers, or terminations of a registration, contact the local (Tucson) DEA office and RLSS.
-

*Modifications include a change in the use and/or storage locations (e.g. laboratory or building moves, new use spaces, etc.).

Separate research locations, such as labs housed within different buildings, requires a separate registration; a single registration with multiple locations on campus for use and/or storage is not compliant with DEA regulation.

4. Purchasing

Anyone purchasing a DEA CS is required to have a registration number, which will be requested at the time of purchase. RLSS does not demand or advocate the use of one controlled substance provider over another. However, the following controlled substance providers have been commonly used by University researchers:

Sigma-Aldrich/Millipore Sigma
Henry Schein
ZooPharm (Requires a Vet Script)

Researchers should only purchase the minimum amount of DEA CS they will need to complete their research objectives.

5. Storage & Security:

- Always keep all DEA CS secured under lock and key and **behind two differently keyed locks**.
    - Only the registrant and authorized dispenser(s) should have access to the keys.
    - Only the registrant, authorized dispenser, and authorized users may use the CEA CS.
    - A DEA approved safe must be used for Schedule I and II drugs, accessible only to authorized personnel. Store Schedule I and II DEA CS separately from all other drugs and reagents.
- Return DEA CS to their approved storage location(s) immediately after use, keeping them locked at all times except when removing, replacing, or actively working with them.
- Maintain only necessary stock as required for normal efficient operation.
- Schedules I-II, the Controlled Substance must be stored in a substantially constructed, securely locked cabinet (safe), separate from other scheduled Controlled Substances, with the cabinet secured to a wall or otherwise not removable, as per federal regulations. RLSS recommends the use of a wall-mounted safe (Schedule 1) or a wall-mounted narcotics cabinet (Schedule II).
- For Schedules III-V, the Controlled Substance must be in a locked cabinet or safe. RLSS recommends the use of a wall-mounted narcotics cabinet.
- Many drugs must remain refrigerated, and these same security requirements apply. RLSS recommends purchasing a fridge narcotics box that can be mounted or somehow locked into the fridge such that the cabinet could not be picked up and taken to a secondary location.

Example:
Schedule I-II

Examples:
Schedule III, IV, V

6. Shipping, Transport, Exporting, and/or Transferring

- Federal law prohibits the export of DEA CS unless certain requirements are met. Special licenses, as well as export and import permits, are required to export controlled substances.
- Controlled substances cannot be transported in personal vehicles; contact Risk Management Services (RMS) for assistance in arranging for any necessary shipping/transport of DEA CS.
- Transferring DEA CS from one researcher to another is acceptable only if the following requirements are met:
    - **Less than 5%** of the Registrant's inventory is transferred: 5% or more constitutes the person transferring as a DEA CS distributor and is outside of the Researcher registration's scope.
    - Both researchers must have valid and current registration and all necessary security and recordkeeping measures must be in place.

- Researchers must document this on their inventory and use logs and complete the RLSS DEA CS Internal Transfer form. Send this to RLSS-help@arizona.edu upon completion of the transfer.
    - DEA CS Schedule I and/or II must also have a Form DEA-222 associated with the transfer.

7. Documentation & Recordkeeping

Registrants, dispensers, and users have many documents and logs that must be maintained as part of a compliant registration. RLSS created templates in tandem with the DEA, which **must** be used for all recordkeeping. All DEA CS records must be kept separately from all other laboratory records, in or near the primary work area (the registered location) and must be available for inspection at any time. Documentation and records will be inspected during routine RLSS and/or DEA inspections. Schedule I and II records **must** be kept separately from Schedule III-V. RLSS recommends creating a binder, physical or digital, for consolidation of all required documentation and records:

- Registration: Registrants will receive both a physical and digital copy of their registration; maintain a copy of this registration that is readily available for inspection.
- Inventories*: Complete the Initial and Periodic Inventories according to the RLSS templates.
    - Initial Inventory: Registrant should start by recording a zero inventory on the day they receive their registration. On the initial inventory, the table will be blank because the Registrant should have zero inventory. Once Controlled Substances are ordered and received, a new inventory **must** be created.
    - Periodic Inventory: Registrant must complete a comprehensive inventory for all DEA CS in their possession **minimally every two years**; a more frequent schedule, such as monthly, is strongly recommended.
- Use Logs*: Complete the RLSS DEA CS Usage log every time a DEA CS is dispensed and/or used; it must be maintained for at least two years.
- Shipping Receipts: Maintain shipping receipts for potential inspection.
- Form DEA-222*: This form applies only to Schedule I and II DEA CS. Use the RLSS log sheet to log all 222 forms and maintain them until the DEA CS has been completely used or otherwise disposed of; at that time, the Registrant must send this back to the local DEA office. Lost or stolen forms must be reported to the DEA.
- Laboratory Specific Training*: This documented training must include a statement, signed by all users/dispensers, that they will report any drug-related felonies to the registrant.
- Power of Attorney Letter: Required if an authorized user is given the authority to sign Form DEA-222s.

*RLSS has created DEA-approved templates (under "DEA Controlled Substances") that must be used.

8. Disposal

- Dispose of controlled substances ONLY under witness from RLSS, the DEA, or by documented return to the supplier or manufacturer.

- Expired material, unused product, and neat waste must be accumulated and stored under lock and key until ready for disposal. Contact Risk Management Services Hazardous Waste (hazmat@email.arizona.edu) to arrange a DEA CS disposal, also known as a DEA Form 41, "reverse distribution."
- Controlled substances injected into research animals, consumed in a reaction, or converted into a non-recoverable hazardous waste mixture may be disposed of through routine waste disposal procedures from Risk Management Services.

9. Reporting of Loss, Destruction, Theft, and/or Unauthorized Use

Report thefts, suspected thefts, unauthorized uses, or other losses of DEA CS to the University of Arizona Police Department, RLSS, and the local DEA Office. Document the incident for submittal to the federal DEA within 72 hours, describing the kinds and quantities of materials and the specific circumstances involved.

10. Additional Resources:

Research Laboratory & Safety Services
rlss.arizona.edu
(520) 626-6850

University of Arizona Police Department (UAPD)
uapd.arizona.edu
911 (any UA phone)
(520) 621-8273 (non-emergency line)

US Dept. of Justice, Drug Enforcement Division (DEA), Tucson Office
https://www.deadiversion.usdoj.gov/
(520) 573-5500

Copies of current drug schedules and federal policies are available on the DEA CS website.

11. Definitions

Authorized User: An individual authorized by a Registrant to use Controlled Substances under the Registrant's direction. Completion of appropriate training is required.

Controlled Substance (CS): Any substance listed in the Controlled Substances Act (21 CFR, part 1300 to end) or Title 54.1, Section 3400 of the Code of Virginia. Lists of Scheduling Actions, Controlled Substances, and Regulated Chemicals are published by the DEA.

Dispense: The term "dispense" means to deliver a Controlled Substance to an ultimate user or research subject by, or pursuant to the lawful order of, a practitioner, including the prescribing and administering of a DEA CS and the packaging, labeling or compounding necessary to

prepare the substance for such delivery. The term "dispenser" means a practitioner who so delivers a DEA CS to an ultimate user or research subject. (21 USC §802(10))

Disposal: Relinquishment of contaminated, expired, excess, residual (or waste), or unwanted Controlled Substances.

University Animal Care (UAC): Manages multiple centralized animal facilities at the University of Arizona and oversees the campus wide animal care and use program. UAC provides assistance to scientists, physicians, staff, and students who have received Institutional Animal Care and Use Committee (IACUC) approval to perform research, testing, or educational studies on animal subjects.

Drug Enforcement Administration (DEA): The agency within the United States Department of Justice that enforces the CS laws and regulations.

Expired and/or Unusable CS: CS for which the expiration date has passed. Or tablets, injections, liquid, or preparations compounded in error that contain Controlled Substances that can no longer be used for research due to contamination, etc.

Registrant: A full-time faculty member who holds a DEA Registration and who is responsible for ordering, storing, using, recordkeeping, and disposing of DEA CS research protocols.

Registration: Formal grant of specific authority for DEA CS activities by the DEA; often referred to as a license or certificate but registration is the proper nomenclature.

Reverse Distribute: To acquire DEA CS from another registrant or law enforcement for the purpose of:

(1) Return to the registered manufacturer or another registrant authorized by the manufacturer to accept returns on the manufacturer's behalf; or

(2) Destruction. (21 CFR 1300.01)

Reverse Distributor A person registered with the DEA as a Reverse Distributor.

Transfer: Moving a Controlled Substance from the inventory of one DEA Registrant to another DEA Registrant.

Use Log: A document completed by each Registrant and Authorized User tracking usage of Controlled Substances. The Registrant must keep Controlled Substances Usage Logs for a minimum of two (2) years from the date of the last transaction.

B-17 Use and Storage of Inert Cryogenic Liquids

1. Purpose

RLSS has created this SOP/guidance to promulgate and ensure safe and compliant operations int areas/facilities/laboratories where inert cryogenic liquids are used and stored have the proper controls, in accordance with the hierarchy of controls.

1. Scope

This applies to all research facilities, laboratories, and spaces using and storing inert cryogenic liquids (e.g. argon, nitrogen, and helium). Four risk levels of hazard for use and/or storage of inert cryogenic liquids have been determined to describe the relative risk and appropriate corresponding control measures. These levels are outlined in Table 1. All facilities where inert cryogenic liquids are used shall be evaluated and assigned a risk level by RLSS.

2. Hazard Description

Cryogenic liquids, or cryogenics, are liquefied gases that are kept in their liquid state at very low temperatures and have extremely low boiling points (below -150°C or - 238°F). They can cause cryogenic burns (cold burns) and may cause structural damage or harm equipment by making materials more brittle. Cryogenic off-gassing releases gases that are colorless, odorless and tasteless; they are not toxic but can be harmful by displacing oxygen in the room. Their high expansion ratio contributes to their potential to create dangerous oxygen deficient atmospheres by displacing ambient air, which creates serious asphyxiation hazards in areas of use and storage. Liquid nitrogen, for example, expands to nearly 700 times its liquid volume when released.

Oxygen Levels (%)	Symptoms of Exposure
19.5	**Minimum oxygen level without adverse effect.**
15 to 19	**Decreased ability to work strenuously. Impaired coordination. Early symptoms.**
12 to 14	**Breathing rate increases, increase in heart rate. Impaired coordination, perception and judgment.**
10 to 12	**Breathing further increases in rate and depth, lips turn blue. Poor judgment.**
8 to 10	**Mental failure. Fainting. Nausea. Unconsciousness. Vomiting.**
6 to 8	**8 minutes – fatal, 6 minutes – 50% fatal, 4 – 5 minutes – possible recovery.**
4 to 6	**Coma in 40 seconds, Convulsions, Breathing stops, Death.**

3. Hazard Evaluation

In order to evaluate the hazard of a space containing inert cryogenic liquids several parameters must be considered:

- The volume present at any given time;
- The size of the laboratory;
- Room ventilation (air exchange rates);
- Proposed use(s) of the cryogen(s);
- Failure modes (including worst-case scenarios) necessary to bring about a hazardous situation.

These parameters, and others as required, are utilized in determining the potential for the creation of an Oxygen Deficiency Hazard (ODH). RLSS must assess these values and assign a corresponding hazard level. If an operation has previously been assessed but operations and/or quantities of cryogen have been altered, a reassessment must be performed; contact RLSS before changes are implemented to ensure adequate control measures are enacted proactively.

4. General Control of Hazards

Please see Table 1 for specific controls that will be required based on the level of the facility and relative risk to workers.

a. Engineering Controls

Ventilation

- **Under no circumstances shall inert cryogenic liquids be stored in an unventilated room**. All areas where cryogenics are used and/or stored must be, at minimum, well-ventilated according to regulations (Note: OSHA states 6 air changes per hour as “well-ventilated”).
- Level 4 facilities required emergency ventilation in areas where oxygen depletion may occur rapidly.

Oxygen Monitors

- Room oxygen monitors **must** be in place in Level 3 and 4 facilities.
  - Monitors must be set to alarm when the concentration of oxygen drops below 19.5%.
  - The number of monitors needed and their placement will depend on the room dimensions, size of the cylinders, the quantity of the cylinders, the types of cryogenic gas being used, whether the gas is being piped into a room, and height of the ceiling.
  - Placement of monitors in the space will be determined by the cryogen in use (e.g. liquid nitrogen is heavier than air and monitors may be located close to the ground).
- Monitors must provide **both** audible and visual alarm when oxygen levels drop below the alarm point.

- Monitor alarms must be noticeable prior entering the cryogen use/storage area(s).
    - Personal badge monitors may be required in addition to external room monitors and alarms.
    - Training and postings must include the necessary response to an alarm.
- Each department/purchaser is responsible for ensuring that the oxygen monitors are operating properly and are calibrated as required.
    - RLSS will keep a record of facilities containing oxygen monitors and will ensure that maintenance is being performed on a regular basis. RLSS and UA Cryogenics may be able to assist in regular certifications and maintenance.
    - Contact RLSS for oxygen monitoring equipment recommendations.

b. Administrative Controls

Administrative controls will be determined on a case by case basis to account for the unique hazards of all spaces using and storing cryogens.

Common administrative controls include but are not limited to:

- Maximum allowable quantity (MAQ) limits for spaces;
- Written standard operating procedures (SOPs);
- A "buddy" or remote check-in system requirement;
- Limited access to hazardous areas;
- Emergency response procedures.

Hazard Communication

- Any facility categorized as level 2 or higher shall have signage and/or warning information posted at the room's entrance.

Level 2 Signage:

- All rooms assigned as risk level 2 must be posted with a sign indicating the presence of an inert cryogenic liquid. The posting will be chosen at the discretion of RLSS.
- The signage will be either:
    - Warning Sign: indicates the potential for low oxygen environments.
    - Danger Sign: indicates the potential for an ODH of <19.5%

Figure 1: Example sign posting for a Level 2 facility

Level 3 and 4 Signage:
All rooms assigned as risk level 3 and 4 must be posted with a sign indicating the following:

- Presence of liquid nitrogen
- Do not enter if facility oxygen monitor alarm is sounding (not to include potential alarms from low liquid levels or other equipment alarms)
- Instructions for what to do in case of emergency

Level 4 facilities must also post entry requirements and may require additional signage or restrictions.

Figure 2. Example sign posting for Level 3 and 4 facilities

Training

- Any person working with or around cryogenic liquids must be trained on the procedures for its use and be made aware of the hazards involved.
- Training must be documented and include trainee signatures and training dates whenever possible.

- General Laboratory Chemical Safety Training is available on the RLSS website.
- Lab specific training must also be provided by the PI/Facility Manager or designee.

- The training received shall provide information on the following topics:
  - Properties and hazards of the cryogen being used;
  - Personal Protective Equipment (PPE) requirements;
  - Facility-specific procedures, including appropriate handling and filling methods;
  - Proper use and function of engineering controls, including oxygen monitors, instrument interlocks, fume hoods, and other room ventilation;
  - Review of all administrative controls;
  - Incident/Exposure response and emergency contact;
  - Transporting cryogenic liquids.

c. Personal Protective Equipment (PPE)

Appropriate PPE is imperative to protecting users from cryogenics burns and must be worn when handling or dispensing cryogenic liquids.

Standard requisite PPE includes:

- Safety goggles,
- Closed-toed shoes, long sleeved shirts and long pants;
- Laboratory coat;
- Gloves (fresh nitrile with thermal gloves over top);
- Face shields (when pouring, filling dewars, or otherwise manipulating cryogens).

5. Storage & Transport of Cryogenic Liquids

Storage

- Cryogens should only be stored in containers specifically designed to house them such as dewars; containers must be insulated and double walled. Store all cryogenic liquid containers upright in well-ventilated areas. Cryogen tanks and containers should not be stored near elevators, walkways and unprotected platform edges or in locations where heavy moving objects may strike or fall on them.

Transport

- Cryogenic liquid containers should be moved on a hand truck, cart, or other appropriate transportation method.
  - Containers need to be secured while being transported and kept upright at all times.
- If inert cryogenic liquids must be transported by elevator, routes and procedures must be evaluated to ensure that the cryogens can be moved safely.

        - Evaluation of the routes must consider the amount of material being transported, the vessel used, typical evaluation rates, and ventilation in all locations, including elevators.
    - Mitigating procedures such as sending containers alone on elevators or keeping others informed as to when cryogenic liquids are being transported may be required based on a hazard assessment.

6. Spill and Incident Procedures

In the event of a spill that poses a threat to health and/or the environment, immediately evacuate the area and call 911. Follow the University Chemical Hygiene Plan's Compressed Gas Standard Operating Procedure and University Chemical Hygiene Plan Section 8 for response, in addition to any site-specific plans or SOPs that are developed in conjunction with RLSS.

Table 1. Risk Levels for Laboratories and Facilities using

Inert Cryogenic Liquids

**Oxygen Deficiency Hazard (ODH)*

Level	Risk	General Requirements	Definition/ Typical Application
1	• Cryogenic burns • Negligible ODH	• Lab Specific Training	Minimal use where a worst-case scenario (e.g. dewar spill) will not bring O_2 level below 19.5%
2	• Cryogenic burns • Minor ODH • Impaired coordination	• Lab Specific Training • Cryogen Signage and Postings: Warning/Danger • Appropriate ventilation	Typical in locations where liquid nitrogen is stored or its use does not require extensive transfer. Worst-case scenario calculations may show that O_2 level may drop between 15-19.5%. Lower levels are possible if 2 independent modes of low probability are required to reach the level.
3	• Moderate to Major ODH • Impaired coordination, perception and judgment	• RLSS hazard assessment • Lab Specific Training • Cryogen Signage and Postings • Ventilation • Oxygen Monitors (personal and/or facility)	Typical in locations where large amounts of inert cryogenics are transferred or where a single failure mode can lead to oxygen levels <15%. **RLSS must be notified to perform a hazard assessment**

4	• Major to catastrophic ODH
	• Mental failure, unconsciousness or death
		• RLSS hazard assessment
		• Lab Specific Training
		• Cryogen Signage and Postings
		• Ventilation
		• Oxygen Monitors (person and/or facility)
		• Additional requirements may be needed, such as:
		  ○ Secured Facility
		  ○ Rescue Oxygen
		  ○ Emergency Ventilation
			Highest hazard level. O_2 level may drop below 12% quickly in the event of a release or failure.
			
			RLSS must be notified to perform a hazard assessment