



University of Arizona

Chemical Hygiene Plan

Research Laboratory & Safety Services

July 2015

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

This document replaces all previous versions of the University of Arizona Laboratory Chemical Safety Manual, and as a regulatory compliance document represents University policy governing the information included herein.

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1 Introduction

The University of Arizona (UA) Research Laboratory & Safety Services (RLSS) is committed to providing a safe laboratory environment for researchers to work and discover, by taking every reasonable precaution to free laboratories of recognizable hazards. UA PIs and teaching laboratory instructors are delegated the local authority, control and responsibility to complete their research/instruction in compliance with applicable regulatory requirements within their areas of influence. Every PI/instructor with responsibility over a hazardous chemical-use laboratory, or set of laboratories, must register into the UA Laboratory Chemical Safety Program. While most PIs will act as their own Approval Holder (AH) and take on the responsibilities as such, some PIs may work under a different AH, not having an approval of their own.

PIs and laboratory instructors are considered “employers” under the OSHA regulations. Therefore, program registration includes the creation of a Laboratory Chemical Hygiene Plan (LCHP) that must be updated annually, or upon significant changes to the chemical hazards or control methods in the laboratory; a LCHP addresses the hazards and controls associated with the hazardous chemicals used or stored in a PI/instructor’s laboratory. Once this LCHP is approved by the RLSS, the PI/instructor will become an “Approval Holder” (AH) and will be able to access and manipulate their laboratory’s “User Dashboard.”

The User Dashboard is available through the RLSS website. It maintains pertinent records related to safety and compliance, including training requirements and completion records, laboratory hazardous chemical inventories, and all relevant plans (including this UCHP and the AH’s LCHP). The RLSS website also contains any forms, policies, and links to outside agencies referenced by this document.

1.1 Purpose

This UCHP 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 the UA 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).

1.2 Scope

This 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 different 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 chemical safety program maintained by Risk Management Services (RMS).

The UCHP shall be made readily available to all PIs, laboratory workers, worker representatives and to the Assistant Secretary of Labor for Occupational Health & Safety, U.S. Department of Labor or designee upon request. Laboratory workers must know 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.

1.3 Rights of a Laboratory Worker

University faculty, staff, laboratory workers, students, volunteers and any other personnel working in a laboratory have the right to access:

- Information on the identity, physical and health hazards of the hazardous chemicals in their work area.
- The OSHA Occupational Exposure to Hazardous Chemicals in Laboratories Standard and the OSHA Hazard Communication Standard.
- Adequate training on how to work safely with chemicals in their work area and what protective measures are available to them to prevent adverse events from occurring.
- Work in a safe environment and to inform the laboratory supervisor, AH or the RLSS about potential risks in the laboratory.

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. To ensure adequate training, every laboratory worker is required to complete the General Laboratory Chemical Safety Training and laboratory-specific training provided by his/her AH or designee. Together, these plans and trainings, as well as the laboratory worker's ability to communicate directly with the RLSS via the User Dashboard, help to create a safe work environment.

1.4 Responsibilities

1.4.1 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 Laboratory Chemical Safety Program to carry out their responsibilities. This is often done through the Office for Research and Discovery and the RLSS.

1.4.2 Vice President for Research

The VPR relies on the RLSS for the development and maintenance of the UA Laboratory Chemical Safety Program. The VPR holds the following responsibilities:

- Ensure chemical safety compliance within the UA research community.
- Provide continuing support for the UA Laboratory Chemical Safety Program.
- Appoint a Laboratory Chemical Hygiene Officer to maintain the Laboratory Chemical Safety Program.
- Appoint an interdisciplinary Laboratory Chemical Safety Committee (LCSC) of professionals with hazardous chemical experience to oversee the University's compliance and organization in hazardous chemical-use laboratories.

1.4.3 Laboratory Chemical Hygiene Officer (LCHO)

The Laboratory Chemical Hygiene Officer is the Manager of Chemical Safety at the RLSS and has primary responsibility for ensuring the implementation of the Laboratory Chemical Safety Program, including the UCHP. The LCHO will function as the LCSC, with assistance from relevant parties, until a functioning LCSC is created. Contact information for the LCHO can be found on the RLSS website.

1.4.4 Laboratory Chemical Safety Committee (LCSC)

The OSHA Occupational Exposure to Hazardous Chemicals in Laboratories Standard recommends the formation of a chemical safety committee for large institutions, including universities. The University of Arizona will form a Laboratory Chemical Safety Committee, whose members are appointed by the VPR. The committee will guide the Laboratory Chemical Safety Program through the University's culture and operations, following the LCSC Charter; a copy of the Committee Charter can be found on the RLSS website. Through regular meetings, the LCSC will review key aspects of the Laboratory Chemical Safety Program and advise the VPR, the RLSS and AHs when extra precautions should be required, based on their knowledge and professional experience.

1.4.5 The Research Laboratory & Safety Services (RLSS)

The RLSS is responsible for administering and overseeing the Laboratory Chemical Safety Program at the UA. In order to accomplish this, the RLSS works with chemical safety AHs to help them achieve and maintain compliance with relevant OSHA regulations. The RLSS also holds the following responsibilities:

- Have working knowledge of current health and safety rules and regulations.
- Review and update the UCHP and University Standard Operating Procedures (USOPs) at least annually.
- Maintain the Laboratory Chemical Safety Committee charter. Before a committee is established and the charter is approved by the VPR, the RLSS will continue to work with department heads of Chemistry & Biochemistry, Pharmacology & Toxicology, University Animal Care and Risk Management Services, 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 regulations.
- Maintain a User Dashboard for every hazardous chemical Approval. The online data includes the UCHP and an AH's LCHP, the AH's authorizations, inventory, and worker training records for the laboratory.
- Perform laboratory hazard assessments and aid in the development of LCHPs and/or Laboratory Standard Operating Procedures (LSOPs).
- Perform scheduled annual inspections of UA hazardous chemical-use laboratories, with follow-up as needed, to ensure compliance with the Laboratory Chemical Safety Program.
- Conduct 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 LCSC, 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 chemical workers or the environment.
- Act as a notification authority in the case of a major chemical spill in the laboratory. In the case of an emergency, the RLSS will act as a liaison between the Incident Commander and/or Risk Management Services Director or designee, and the laboratory.
- Aid in chemical laboratory closures, ensuring proper relocation, disposal, and decontamination of legacy hazardous chemicals.
- Maintain records of all hazardous chemical laboratory inspections, exposure monitoring and emergency responses.
- Monitor building/site aggregate chemical inventories for compliance with the Chemical Facility Anti-Terrorism Standards (CFATS).

1.4.6 Risk Management Services (RMS)

Risk Management Services is responsible for chemical safety for employees working outside of a laboratory environment at the UA, and also holds responsibility for the following aspects of the Laboratory Chemical Safety Program:

- Perform Industrial Hygiene (IH) assessments and provide guidance and technical assistance to the RLSS regarding health, safety, and environmental problems in chemical-use laboratories, upon request of the RLSS.
- Provide and maintain the Respiratory Protection Program.
- Provide the "Fighting Fires with Portable Fire Extinguishers" training for laboratory workers; provide guidance and assistance to the RLSS on International Fire Code compliance issues in hazardous chemical-use laboratories.
- Provide a safe, efficient mechanism for the removal of hazardous chemical wastes (excluding radioactive materials, compressed gases in cylinders larger than lecture bottles and non-returnable lecture bottles) from hazardous chemical-use laboratories and arrange for proper management and disposal of those wastes.
- Perform Occupational Safety and Health Administration (OSHA) accident reporting and filing for worker's compensation.

- Act as the Incident Commander or advisor to the Incident Commander during chemical-related emergencies such as major chemical spills and accidents.
- Provide the RLSS with technical assistance in the clean-up of minor spills.
- 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, Industrial Hygiene (IH) assessments, emergency responses, and hazardous waste activities.

1.4.7 Approval Holder

Though the AH may assign an Approval Safety Coordinator (ASC) to perform many, if not all, of the responsibilities listed below, the AH is ultimately responsible for ensuring that his/her laboratories are compliant with the Laboratory Chemical Safety Program. The RLSS is available to assist with all of the AH's responsibilities, primarily through the User Dashboard. The AH's responsibilities are to:

- Maintain a Chemical Safety Approval with the RLSS to include completing an Approval Holder Orientation (AHO) with the RLSS every three years.
- Know all applicable health and safety rules and regulations, training/reporting requirements, and SOPs associated with chemical safety for the substances used in his/her laboratory.
- Recognize any hazardous conditions or operations within the laboratory. Contact the RLSS for assistance with determining safe procedures and controls and implementing enforce standard safety procedures.
- Work with the RLSS to develop, publish and implement a LCHP and relevant Laboratory Standard Operating Procedures (LSOPs). Review and update the LCHP and LSOPs at least annually.
- Complete the RMS "Fighting Fires with Portable Fire Extinguishers" course and share the information learned with his/her laboratory workers.
- Ensure all laboratory workers under his/her direction successfully complete the General Laboratory Chemical Safety Training provided by the RLSS.
- Provide and document Laboratory Specific Training to laboratory workers within his/her laboratory.
- Provide and document orientations for laboratory visitors.
- Ensure appropriate personal protective equipment (PPE) is available to laboratory workers.
- Provide prior-approval to laboratory workers for the use of certain hazardous chemicals in the laboratory; consult the RLSS on the use of particularly hazardous 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.
- Investigate and report incidents to the RLSS; report injuries to both the 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, inspections and corrective actions taken.

1.4.8 Approval Safety Coordinator

An AH may or may not appoint an ASC to carry out select responsibilities and act as a point of contact for the RLSS. An ASC may therefore have some or all of the responsibilities listed Section 1.4.7. An ASC is first and foremost a laboratory worker, however, and is therefore also required to carry out all responsibilities in Section 1.4.9. All ASCs must complete an Approval Safety Coordinator Orientation with the RLSS every three years.

1.4.9 Laboratory Worker

A laboratory worker is anyone who works or volunteers in a laboratory at the UA; the AH and ASC are also considered laboratory workers, though some differences in responsibilities may apply. Teaching assistants in instructional laboratories are also considered laboratory workers.

Laboratory workers under a chemical safety approval also have access to the RLSS User Dashboard. This system will allow them to view all required information and documentation, as well as affirm to reading and understanding required documents. Laboratory workers hold the following responsibilities:

- Read and follow the requirements of the UCHP and LCHP, as well as any other appropriate procedures (i.e. University or Laboratory Standard Operating Procedures).
- Complete the General Laboratory Chemical Safety Training; keep a copy of all completion records.
- Complete Laboratory Specific Training with his/her AH or ASC.
- Complete any other health and safety training as required by the LCHP (e.g. Respirator Fit Testing).
- Plan and conduct each laboratory experiment or operation in accordance with the Laboratory Chemical Safety Program.
- Understand the capabilities and limitations of PPE provided.
- Gain prior approval from the AH/ASC for the use of restricted chemicals and other materials; consult with the AH/ASC before using new or changed particularly hazardous chemicals or conducting certain high-risk experimental procedures.
- Develop good personal chemical safety habits; this includes keeping the work areas safe and uncluttered.
- Immediately report all accidents and unsafe conditions to the AH/ASC.
- Supervise students in teaching laboratories, if a teaching assistant.
- 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 Facilities Design and Construction, are in proper working condition (e.g. fire extinguishers, fire alarm systems, emergency eyewashes and showers, and chemical fume hoods).

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 Department of Procurement and Contracting Services Stores and the University Research Instrumentation Center (URIC) Cryogenics & Gas Facility

The Department of Procurement and Contracting Services Stores are responsible for the safe procurement and delivery of all chemicals purchased through them with University funds. The University Research Instrumentation Center (URIC) Cryogenics & Gas Facility is responsible for the safe procurement, delivery and disposal/return of compressed gases in cylinders larger than lecture bottle size and cryogenic dewars purchases/rented through them with University funds.

University laboratories at satellite locations (i.e. College of Medicine Phoenix, etc.) may utilize other companies and facilities for the procurement, delivery and disposal of hazardous chemicals and compressed gases.

1.4.12 University of Arizona Police Department (UAPD), Tucson Fire Department (TFD) & Emergency Medical Technician (EMT)

University Police, the Tucson Fire Department and Emergency Medical Technicians provide emergency services to laboratory personnel (e.g. medical, fire, major spill response, security).

For life-threatening situations or work-related injuries or illness, 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.

1.4.13 Campus Health Services Occupational Health Clinic

The UA Campus Health Services Occupational Health Clinic holds the following responsibilities:

- Provide treatment and referral for work-related injuries and illnesses to university employees and students.
- Provide medical surveillance to University employees on the main Tucson campus.

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

1.4.14 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.

1.4.15 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 7.4 for further information. Visitors who are not working with hazardous chemicals (e.g. tour groups) must always be supervised when in the laboratory; these 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 approval, nor do they need to complete the General Laboratory Chemical Safety Training. However, he/she will need to:

- Complete and document Laboratory Specific Training with the AH or ASC.
- Always be supervised by an approved laboratory worker whenever working in the laboratory.

Visiting researchers or students working in the laboratory for more than two weeks must be added to the 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 unsupervised in the laboratory with hazardous chemicals.

2. Hazard Communication

The University of Arizona Laboratory Hazard Communication Program is a part of the Laboratory Chemical Safety Program; the Hazard Communication Plan required by OSHA 29 CFR 1910.1200 is incorporated within this UCHP. The Hazard Communication Program is designed to ensure all laboratory workers and their personal physicians (upon request) have the right to receive information regarding the hazardous chemicals they've been exposed to in the laboratory. This information is provided by a laboratory worker's AH and/or ASC, as well as the 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 most 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.

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 the UA 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. A 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. The RLSS Reference Guide to GHS Chemical Container Labels is available on the RLSS website and should be used to assist with classifying the hazards of mixtures for generation of container labels and SDSs. Assume the mixture to be more toxic than the most toxic component in the mixture.

2.2 Chemical Hazard Categories

The UA 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 detail in Chemicals and Procedures Requiring Prior Approval

2.2.1 Non-Hazardous Chemicals

Chemicals that do not present a physical or health hazard are considered to be non-hazardous. These chemicals do not have to be entered into the User Dashboard hazardous chemical inventory. However, all chemical containers should be labeled with the chemical's full name to ensure it is not mistaken for a hazardous compound.

2.2.2 Hazardous Chemicals

A hazardous chemical has significant evidence of presenting a physical or health hazard. While potentially dangerous, these chemicals are of lower risk than those categorized as particularly hazardous chemicals. AHs using or storing only hazardous chemicals will develop simpler LCHPs and will undergo a less stringent Laboratory Chemical Safety Committee (LCSC) review.

2.2.3 Particularly Hazardous Chemicals

Particularly hazardous chemicals present higher risks than hazardous chemicals and are defined by OSHA to include "select carcinogens, reproductive toxins and substances which have a high degree of acute toxicity." The use of particularly hazardous chemicals shall be given specific

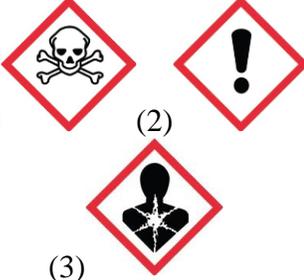
consideration by the AH in the development of the LCHP. In addition to a more detailed LCHP, AHs using or storing particularly hazardous chemicals will undergo a more stringent committee review and LCHP approval process.

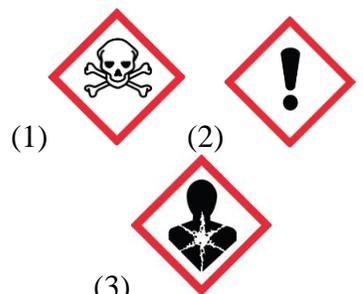
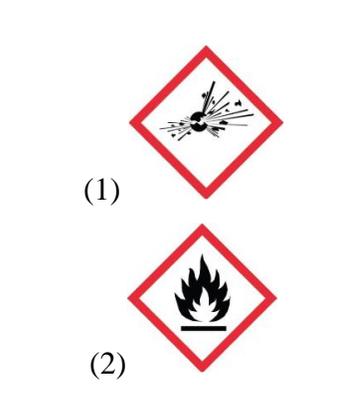
2.3 Hazard Classification System

The UA has adopted the Globally Harmonized System for the classification of hazardous chemicals. Manufacturers classify their chemicals according to GHS “hazard statements,” which explain the type of hazards presented by each chemical. The GHS also assigns a set of standard control measures to address each hazard statement, known as “precautionary statements.”

The RLSS has grouped the GHS hazard statements into 11 general hazard classes. The hazard class(es) of a chemical will determine how it should be stored, handled and disposed of. It is essential that all laboratory workers understand this hazard classification system and can recognize their potential routes of exposure. One UA Standard Operating Procedure (USOP) has been created for each of the 11 hazard classes by the RLSS; these USOPs cover the hazards presented by each class, as well as required control measures and emergency procedures.

The table below lists the RLSS hazard classes, their related GHS hazard statements, and associated hazard pictograms. The hazard class and category of each chemical are available to laboratories through the online User Dashboard hazardous chemical inventory.

Hazard Class	GHS Hazard Statements	GHS Hazard Pictograms
Delayed Health Hazard ^a	May cause an allergic skin reaction May cause allergy or asthma symptoms or breathing difficulties if inhaled May cause cancer Suspected of causing cancer Causes damage to organs through prolonged or repeated exposure May cause damage to organs through prolonged or repeated exposure	
Developmental & Reproductive Toxins ^b	May cause genetic defects Suspected of causing genetic defects May damage fertility or the unborn child Suspected of damaging fertility or the unborn child May cause harm to breast-fed children	
Inhalation Hazard	Fatal if inhaled (1) Toxic if inhaled (1) Harmful if inhaled (2) May cause respiratory irritation (2) May cause drowsiness or dizziness (2) Causes damage to organs (3) May cause damage to organs (3)	

Hazard Class	GHS Hazard Statements	GHS Hazard Pictograms
Contact (Eye & Skin) Hazard	Fatal in contact with skin (1) Toxic in contact with skin (1) Harmful in contact with skin (2) Causes skin irritation (2) Causes serious eye irritation (2) Causes damage to organs (3) May cause damage to organs (3)	
Ingestion Hazard	Fatal if swallowed (1) Toxic if swallowed (1) Harmful if swallowed (2) May be fatal if swallowed and enters airways (3) Causes damage to organs (3) May cause damage to organs (3)	
Corrosive	May be corrosive to metals Causes severe skin burns and eye damage Causes serious eye damage	
Highly Reactive ^c	Heating may cause an explosion (1) Heating may cause a fire or explosion (1,2) Heating may cause a fire (2) Catches fire spontaneously if exposed to air (2) May Catch Fire: Self-heating (2) May Catch Fire: Self-heating large quantities (2) In contact with water releases flammable gases which may ignite spontaneously (2) In contact with water releases flammable gases (2)	
Explosive	Unstable Explosive Explosive: mass explosion hazard Explosive: severe projection hazard Explosive: fire, blast or projection hazard Fire or projection hazard May mass explode in fire	

Hazard Class	GHS Hazard Statements	GHS Hazard Pictograms
Flammable	Extremely flammable gas Flammable gas Extremely flammable aerosol Flammable aerosol Extremely flammable liquid and vapor Highly flammable liquid and vapor Flammable liquid and vapor Flammable solid	
Oxidizing	Oxidizer: may cause or intensify fire Strong Oxidizer: may cause fire or explosion Oxidizer: may intensify fire	
Compressed Gas	Contains gas under pressure, may explode if heated Contains refrigerated gas, may cause cryogenic burns or injury	

a) Includes sensitizers, select carcinogens and target organ toxins from prolonged or repeated exposure. b) Includes germ cell mutagens and reproductive toxins. c) Includes self-reactive, organic peroxides, pyrophoric and water-reactive chemicals.

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 the UA Laboratory Hazard Communication Plan.

2.4.1 Chemical Inventory

Every AH that uses hazardous chemicals must maintain an up-to-date inventory of the hazardous chemicals used or stored in each laboratory (room by room) through the 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.).

The hazardous chemical inventory must be updated regularly. 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 User Dashboard hazardous chemical inventory screen allows for AHs, ASCs, or designated laboratory workers to update their 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 to the RLSS Chemical Database by completing the “Chemical Database Addition Request Form” found on the RLSS website. 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 (Material) Safety Data Sheets

A (M)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. By December, 2015, manufacturers and distributors of chemicals must not distribute hazardous chemicals unless they are labeled in accordance with the GHS and they have an attached SDS.

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

2.4.3 Hazardous Chemical Container Labels

All chemical containers in a laboratory must be properly labeled at all times. This includes containers of non-hazardous chemicals (e.g. distilled water) to avoid confusion 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. All original containers of hazardous chemicals from the manufacturer must be labeled with the GHS information below.

- 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 one of the required GHS label elements listed above. Laboratories can print GHS-compliant labels for older containers and secondary containers from the RLSS User Dashboard hazardous chemical inventory. For more information on how to create a GHS-compliant chemical container label, see the “Reference Guide to GHS Chemical Container Labels” on the RLSS website.

2.4.4 Room Signage

Every laboratory using hazardous chemicals must obtain a Hazardous Chemical Laboratory Posting from the RLSS. This label will include the applicable hazard pictograms relating to the laboratory’s overall online chemical inventory to warn non-laboratory workers about what hazards are present inside the laboratory. The 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 the RLSS for a replacement posting.

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. Flammable cabinets must be labeled with the 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 of food or drink for human consumption 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, though it is not required. Contact the RLSS to obtain any required storage area labels.

3. Standard Operating Procedures

3.1 University SOPs (USOPs)

USOPs provide more detailed information about the safe use of hazardous chemicals in different situations. All laboratory workers at the UA 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 Hazard Class are described in specific Hazard Class USOPs. Other USOPs include “Unattended Reactions,” “Proper Use of a Chemical Fume Hood” and “Use of Hazardous Chemicals in Animals.” All USOPs are included in Appendix B; they are also available as separate documents on the RLSS website.

3.2 Laboratory SOPs (LSOPs)

Some procedures are specific to each laboratory and cannot be covered in the general USOPs. These procedures must be documented as LSOPs to address the specific chemical hazards and situations expected in the laboratory. LSOPs are required for the use of hazardous chemicals with their own OSHA vertical standard (49 CFR 1900.1001 – 1910.1052); examples of such chemicals include 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, or that are meant to mitigate hazards presented to laboratory workers.

All of an Approval's LSOPs must be included in the Approval's LCHP. Their relevance and effectiveness must be evaluated annually, with the rest of the LCHP. See the RLSS website for a 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. The RLSS works with the laboratory through regularly scheduled inspections and providing additional requested assessments to determine appropriate methods of controlling exposure to hazardous chemicals. The RLSS also assists with the implementation of recommended control measures; contact the 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:

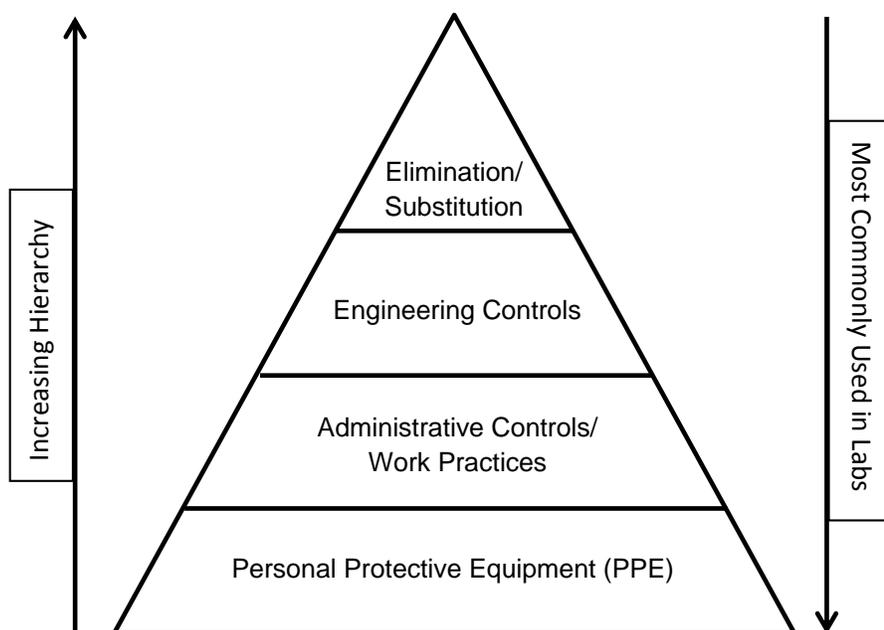
- Acute exposure: Acute effects occur from a sudden and severe exposure to hazardous chemicals. They are often reversible (e.g. carbon monoxide or cyanide poisoning).

- 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.



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 greenchemistry.org. 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 built into the design of a laboratory and act as the first line of defense against exposure. These controls can include modifications to equipment, ventilation systems and processes, all of which are designed to reduce the source of exposure. As long as they are maintained, engineering controls can be very 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 will be higher than implementing administrative controls or buying personal protective equipment, the operating costs are usually lower over the long term.

4.4.1 Building Ventilation

General building ventilation allows for outside air to be brought inside, 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, laboratory ventilation should completely replace the inside air at least 6 times per hour to prevent the buildup of hazardous atmospheres; this would produce a “well-ventilated area.” Such ventilation is not always possible, especially in older buildings. Hazardous chemical-use laboratories must at least constitute a “ventilated area,” in which there is some measurable air movement into the laboratory. If a laboratory does not constitute a ventilated area, the RLSS may approve of the use of certain chemicals if the laboratory can be classified as a “passively ventilated area” because it allows air movement through windows, fans, etc.

While some buildings are more adept at maintaining negative pressure within laboratories than others, Facilities Management works to achieve negative pressure for hazardous chemical laboratories. Proper airflow in a building is the responsibility of the University, 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; doors must not be propped open. The RLSS will assess laboratory ventilation for adequacy during chemical safety inspections and upon request.

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, 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 the use of all particularly hazardous chemicals, and should be used for procedures using hazardous chemicals that may result in the release a gas, vapor or dust. Fume hoods are very effective at minimizing exposure to hazardous chemicals, but should not be used with biohazardous materials.

The annual maintenance and calibration of fume hoods is the responsibility of Facilities Management. However, it is the responsibility of the AH to ensure the fume hood is used properly, and to notify Facilities Management when maintenance is required. 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 ventilated to a local exhaust system like a fume hood. Instead, the air is drawn through a filter and recirculated to the work area. Therefore, hazardous chemicals should not be used inside of most biosafety cabinets. Contact the RLSS to approve of the use of full-ventilated BSCs (e.g. Class II Type B2 or modified Class II Type A2) for hazardous chemical work.

4.4.4 Local Exhaust Snorkels

Snorkels are local exhaust systems that capture hazardous dusts, vapors or gases produced in small areas or by individual instruments. These devices also exhaust through the building’s local ventilation system. They are less effective than chemical fume hoods, however, since the hazard is not as well contained and they are not certified annually by Facilities Management.

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 an inert atmosphere when working with sensitive compounds. 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 leaking hazardous gases before laboratory workers are exposed. Gas cabinets should be used to house hazardous gas cylinders, especially for those requiring prior approval (see Section 7). 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.

4.4.7 Flammable Cabinets/Refrigerators

Fire code requires that laboratories store no more than 10 gallons of flammable chemicals outside of an approved flammable cabinet. Approved flammable cabinets may be found under chemical

fume hoods or as stand-alone storage cabinets. They 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.

Per fire code, no more than 60 gallons of flammable liquids may be stored inside a single flammable cabinet. No more than three approved flammable cabinets may be located in a single room, unless that room qualifies as an “inside storage room.” Further information on inside storage rooms may be found in the OSHA 29 CFR 1910.106 Standard. 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.

Flammable liquids should not be stored in an unmodified domestic refrigerator; many sources of ignition exist within them, including the light bulb. A refrigerator 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.

4.4.8 Other Safety Equipment

AHs must ensure that safety equipment other than that mentioned above is inspected and maintained by 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, faucet mounted eyewashes, etc.

4.5 Administrative Controls

Administrative controls can limit worker exposure to hazardous chemicals by:

- Limiting the 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. Prior planning may also 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; this process is discussed in more detail in Section 9.

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. The 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 are available to protect them. All laboratory workers under an Approval will be able to access these documents; each worker must

read both plans and use the 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, but 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. In fact, administrative controls should always be used to help control chemical hazards.

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 respirator cartridges.

Every person working in a UA 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
- Full-length pants
- Laboratory coat
- Safety glasses
- Disposable examination-type gloves (nitrile or latex)
 - Only if working directly with hazardous chemicals

In general, all hair, jewelry and clothing should be tied back or otherwise controlled to keep from being loose and interfering with required personal protective equipment. Work with your AH/ASC or the RLSS to determine how to control loose clothing required by religion (i.e. hijab, burka, etc.).

The AH must 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 acquiring 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. All PPE must be kept in a sanitary and reliable condition.

AHs are required to update PPE requirements in their LCHP when new chemicals or activities require increased protection. Contact the RLSS for assistance with hazard assessments when chemical use is changed. See the “PPE Selection Guide” on the RLSS website for further information when determining appropriate PPE for an experiment or process.

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 people are less likely to touch their faces with gloves on their hands. Nitrile and latex examination gloves are the most common 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 holes, cracks or contamination before use. Discard any gloves found to be inadequate or questionable.
- Replace gloves periodically; all glove materials are eventually permeated by chemicals. Manufacturers generally provide information on breakthrough and compatibility.
- Discard disposable gloves immediately after each use and whenever they become contaminated.
- Rinse reusable gloves with soap and water, carefully remove them and allow them to dry completely for storage after each use.
- Remove gloves prior to leaving the laboratory to prevent chemical contamination. Be sure to wash your hands thoroughly with soap and water after your gloves have been removed.
- 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 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.

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.
- 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.
- Don't wear laboratory coats outside of the laboratory or take laboratory coats home.
- If laboratory coats become contaminated they should be:
 - Decontaminated or cleaned. Shaffer Dry Cleaning & Laundry provides a lab coat laundry service to UA researchers. To start service for your laboratory, call Shaffer at 520-318-2538. Further information can be found on the RLSS website.
 - Disposed of as hazardous material.
- 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 while in any laboratory where chemicals are being used or stored, even when not working directly with chemicals. Additional face protection, such as splash goggles and face shields provide extra protection to the eyes and face. They should only be used in addition to eye protection, 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.

4.6.5 Respiratory Protection

Respirators are generally not recommended for controlling chemical exposures in the laboratory environment. 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 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.
- 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.

There are numerous types of respirators available; each one has specific limitations and applications. All respirator use requires training and fit-testing to a specific respirator model and size. Individuals under a chemical safety approval must register into the UA Respirator Program through Risk Management Services in order to use respirators in a laboratory; an assessment from the RLSS is required for registration to protect against chemical exposure. To register into the program, read the Respiratory Protection information on the Risk Management website and complete the “Industrial Hygiene and Safety Services Request Form” at risk.arizona.edu. After registration, laboratory workers must complete a medical review, which includes a medical questionnaire and possible medical physical exam, as well as training and a fit testing session.

AHs must identify work requiring respiratory protection (with the aid of the RLSS 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 the Respiratory Protection Program, contact Risk Management Services.

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. 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, and storage areas should never be overcrowded.

Laboratory shelves should have a raised anti-roll lip, and all chemicals 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 beyond their expiration date. If chemicals expire, have deteriorated, have questionable labels, are leaking, or have corroded caps, contact Risk Management Services for the collection of the expired hazardous chemicals.

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 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 International Fire Code (IFC) storage quantity limits exist for flammable liquids (Section 4.4.7) and hazardous gases (Section 7.2). The RLSS may defer or coordinate laboratory concerns regarding IFC regulations through the University Fire Inspector at Risk Management Services.

4.7.3 Segregation

Hazardous chemicals must be stored, segregated, or separated according to compatibility so that they cannot accidentally come into contact with 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.

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 [$\geq 1N$] segregated from concentrated bases)
- Oxidizers
- Flammable Liquids
- Highly Toxic
- Highly Reactive

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. Ideally, flammable chemicals should be stored in a certified flammable cabinet.
2. Isolation – Isolate any chemicals that have a tendency 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. Corrosive Characteristics – After flammability and isolation are taken into account, 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 Transport and Shipment of Hazardous Chemicals

The Laboratory Chemical Safety Program distinguishes between the shipment of hazardous chemicals and their transport. The shipment of hazardous chemicals by a third party carrier by ground, air or water requires compliance with transportation regulations (i.e. the 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 the RLSS to determine if your planned transport of chemicals is considered transport or shipment.

4.8.1 Hazardous Chemical Shipment

The shipment of hazardous chemicals requires adequate training on the 49 CFR and other applicable regulations. Risk Management Services provides this training for shipment of biological samples on dry ice. They may also assist with hazardous chemical shipments for UA laboratories, including the completion of Department of Transportation (DOT)-required paperwork. Contact the RLSS if you believe a shipment of hazardous chemicals is required, if you have questions on shipping requirements, or if you need a hazardous materials determination; the RLSS will coordinate shipments with RMS.

4.8.2 Hazardous Chemical Transport

Hazardous chemicals can be transported by hand, cart or vehicle while not in commerce. Use secondary containment (e.g. a rubber pail) when transporting one or two 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.

The transport of hazardous chemicals is permitted in a University-owned vehicle, provided the chemical is placed in tertiary containment (e.g. in its original container, a sealed Ziploc bag and a sealed cardboard box with absorbent materials) and the transport is not in commerce. Hazardous chemicals may not be transported in privately-owned vehicles, according to University policies. Hazardous chemicals may not be transported using public (i.e. city bus, Sun Link) or public-like (i.e. CatTran) transportation.

4.8.3 Field Use of Hazardous Chemicals

Hazardous chemicals may be transported to, and used in, field sites for UA research. The transport requirements mentioned above must be followed. In addition, field use of hazardous chemicals should minimize glass and 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 or plumbed eye wash station
- Adequate PPE (contact the RLSS to determine appropriate PPE for specific field work)

Additional items, such as a fire extinguisher and a chemical spill kit, may also be required depending on the RLSS assessment.

4.9 Hazardous Waste Disposal

The proper disposal of hazardous chemicals is necessary to prevent chemical exposure, unplanned reactions and to allow for cost-effective disposal. Risk Management Services is responsible for the removal of hazardous chemical waste from laboratories and for ensuring the proper transport, packaging and disposal of said waste. The AH/ASC is responsible for ensuring hazardous chemical waste is properly managed in the laboratory before it is collected. This responsibility includes proper segregation and identification of waste.

The RLSS and RMS provide 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.

4.9.1 Waste Minimization

Waste minimization techniques should be practiced within every laboratory to allow the UA 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.

Risk Management Services 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 the 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.

4.9.2 Drain Disposal

Very few chemicals are allowed to be disposed of in the sink, which leads to publically-owned treatment works. The following chemicals and chemical types are allowed down the drain when flushed with at least three times the 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. Acidic solutions may be neutralized to be brought within this range before drain disposal if they do not contain any other hazardous materials.

4.9.3 Storage and Segregation

The preferred storage container for liquid waste is a 3.5 gallon plastic bucket from Sun West Containers; they must be labeled with the yellow Hazmat label. Refer to the “Common Purchase List” on the RLSS website for information on appropriate product numbers, etc. 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; if you write your building name, room number and name on the bucket, that same bucket will be returned to you once 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 these waste buckets, the container must be compatible with the chemical waste. The original label on the container must be fully defaced and the container should be decontaminated. 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.

All waste containers must have a RMS Waste Identification Tag, 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 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

4.9.4 Hazardous Waste Collection

Submit a waste pick-up request to RMS when chemical waste containers are $\frac{3}{4}$ 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 Risk Management Services at 621-5861.

4.9.5 Unlicensed Radioactive Material Disposal

There are some radioactive compounds that do not require a radioactive materials license or registration into the UA 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 the RLSS, not as hazardous chemical waste. To request collection of an unlicensed radioactive material, complete an online radioactive waste pickup request.

4.10 Pregnancy Counseling

It is strongly recommended that any pregnant woman, or woman who plans on becoming pregnant, working with hazardous chemicals that fall into the Developmental & Reproductive Hazard class, obtain more detailed information on the hazards of that chemical and ways to protect themselves and their unborn child. The RLSS is available to provide basic counseling on the use of developmental and reproductive toxins. 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 these chemicals in your laboratory, call 1-888-285-3410.

5. Maintenance of Protective 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, call Facilities Management (FM) at 621-3000 and submit a work request. There is no charge for these services. If an AH or ASC is brought aware of a piece of equipment that is past due for its inspection, he/she must contact FM 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.

5.1 Chemical Fume Hoods

It is up to the AH and/or ASC to ensure their fume hoods are not overcrowded, and that their sash is pulled down to the appropriate line, especially when in use. Chemical fume hoods are tested and certified by FM on the main campus and some satellite locations annually. After a fume hood passes the FM testing procedures, it will receive an inspection label indicating when the fume hood was last inspected, who completed the inspection, what type of use it is certified for (e.g. general chemical-use, perchloric acid use, radioactive material use), and the maximum sash open position.

An uncertified chemical fume hood should not be used to control hazardous chemicals. If it is absolutely necessary that certain functions involving hazardous chemicals be performed in an uncertified fume hood before FM can recertify it, contact the RLSS. The RLSS can perform face velocity measurements to determine if the fume hood is appropriate for hazardous chemical use before FM certification.

5.2 Decontamination Devices

Emergency safety showers, eye wash stations and dousing stations are inspected by FM (or third party vendors for satellite locations) quarterly. At the time of FM inspection, the decontamination device will receive an inspection tag, indicating when it was last inspected and by whom.

All eye wash and dousing stations should be flushed by laboratory personnel on a weekly basis. Detachable faucet-mounted eye-washes are not inspected by Facilities Management. The AH/ASC must ensure these devices are inspected by laboratory workers quarterly; further information on these inspections and the required inspection tag are on the RLSS website. The AH/ASC is also responsible for ensuring access to decontamination 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

FM (or vendors for satellite locations) performs annual inspections of most portable and non-portable fire extinguishers in laboratories. A physical check of fire extinguishers should be performed monthly by a member of the laboratory or building staff.

At least one person working in the laboratory should complete the fire extinguisher training provided by Risk Management Services; this is usually the Approval Safety Coordinator. 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 the RLSS during annual audits to ensure adequate ventilation. Certification labels will be placed on gas cabinets that pass the quantitative assessment. Contact the RLSS to schedule an assessment of any new gas cabinets, or gas cabinets that have been significantly modified since the last inspection.

Other equipment and devices, including medical devices (e.g. isoflurane vaporizers, gas monitors, ophthalmology excimer lasers, etc.) are not inspected or certified by FM or the 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 in the proper use of these devices.

6. Particularly Hazardous Chemicals

Additional safety-related requirements apply to the use or generation of particularly hazardous chemicals. Each chemical in the RLSS Chemical Database is classified as a non-hazardous chemical, a hazardous chemical, or a particularly hazardous chemical. When an Approval adds a chemical to his/her inventory using the User Dashboard, that classification will automatically appear, informing the Approval of which chemical(s) require additional precautions.

6.1 Designated Area

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. 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 using different cabinets or secondary containment.
- Benches or other work surfaces that may become contaminated by routine use of particularly hazardous chemicals should be fitted with removable absorbent material.

For more detailed information on the creation of a designated area and the required labeling, or to obtain Designated Area Labels, contact the RLSS at 626-6850.

6.2 Containment Devices

Particularly hazardous chemicals should be used in some kind of 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 used in a chemical fume hood or similar containment devices. 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 must be assessed by the RLSS to ensure laboratory workers are not over exposed.

6.3 Safe Removal of Contaminated Waste

Some particularly hazardous chemicals may require special procedures 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 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 in the proper procedures.

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, work spaces, 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 the RLSS is required for the use of certain hazardous chemicals or the performance of certain activities involving hazardous chemicals.

7.1 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 clinical and research use. Any use of a controlled substance must be under the oversight of an individual registered with the DEA; any person handling a registrant's controlled substances must be listed as an "agent" under the registration. Researchers are expected to acquire their own DEA registrations, as these registrations are specific to research protocols and responsible individuals.

This section of the UCHP defines requirements for PIs with a DEA researcher or practitioner registration; these requirements do not apply to DEA chemical analysis registrants.

7.1.1 Application Process and Fee Exception

An individual in a laboratory must apply for a registration with the DEA using the DEA Form 224 or 225 before ordering, receiving or dispensing controlled substances. There is no state licensing agency for controlled substances in Arizona; when completing an application, leave the “State License Number” and “Expire Date” fields blank. University researchers may be exempt from DEA registration fees associated with Form 224/225 if they qualify; contact the RLSS for further information about eligibility for this fee waiver. The RLSS can also assist researchers with the registration process.

DEA registrations are specific to the substance itself and the research being performed. Registrants will need to contact the DEA and update their registration before using new controlled substances.

7.1.2 UA Controlled Substances Classification

Controlled substances are classified into 5 “schedules” by the DEA, with Schedules 1 and 2 requiring more stringent storage and recordkeeping practices than Schedules 3-5. Some schedules have sub-categories, such as schedule 2 (narcotic) and schedule 2N (non-narcotic).

Controlled substances are considered hazardous chemicals, and are therefore included within Laboratory Chemical Safety Program inspections. Research laboratories that receive or dispense controlled substances must be registered in the Laboratory Chemical Safety Program through the RLSS. Each registrant is responsible for his/her own use and storage of controlled substances. The RLSS inspections assist Approval Holders with maintaining compliance with DEA regulations.

7.1.2 Security Requirements

All DEA applicants and registrants must provide effective procedures and control measures to guard against diversion of controlled substances, including dilutions of controlled substances. If the physical security controls of a laboratory become inadequate (i.e. the registrant applies for a new schedule, the quantity of controlled substances being stored in the laboratory increases, or a previously uncontrolled substance is added to a schedule), the registrant must adjust the physical security controls accordingly; contact the RLSS for assistance.

Access to a registrant’s controlled substances must only be allowed for certain authorized members. These laboratory workers must be listed as “agents” on the DEA registration form, which allows them to secure, dispense and administer the registrant’s controlled substances. Agents must be under the control and direction of the registrant and must not have been convicted of a drug-related felony. A registrant may not share controlled substance storage space with another registrant; all controlled substance storage locations must be secure from any personnel other than those listed as agents under the registration. Minors cannot have access to a registrant’s controlled substances and must not be listed as agents under a registration.

As per the DEA's security manual, controlled substances in Schedules I and II must be stored in a securely locked, substantially constructed cabinet, safe or vault that is affixed to the storage space by bolts (or other means) if under 750 pounds. DEA controlled substances in Schedules III-V must be stored in a securely locked, substantially constructed cabinet. If access to these cabinets is controlled by key locks, substantial key control practices and procedures must be documented and adhered to, to ensure access is allowed only for limited laboratory workers. Only 240cc (48 doses) of substances containing opium and 120cc (24 doses) of other controlled substances can be dispensed at one time. Any dispensed controlled substances that remain unused at the end of a work shift must be returned to the registrant's storage location or disposed of accordingly.

7.1.3 Recordkeeping Requirements

All DEA-required records must be retained at the registrant's location for at least 2 years, including copies of the inventory and registration forms (DEA Forms 224 or 225), transfer forms (DEA Form 222), etc. Notify the DEA if you are moving buildings, rooms, etc.; your registration must be updated. All stock and diluted solutions of controlled substance must be labeled with the substance name, strength, quantity and expiration date.

An initial inventory of controlled substances must be documented the day the DEA registration number is assigned; the quantity of controlled substances in possession at this time should be 0. After the initial inventory has been taken, the DEA registrant must perform and document a new inventory of all controlled substances possessed under their registration at least every two years. Inventory records of Schedule I and II controlled substances are considered sensitive information and must be secured separately from all other records of the registrant. Each inventory must be retained at the registered location for at least 2 years from the date the inventory was taken, and must include the following information:

- The date that the inventory was conducted
- Whether the inventory was taken at the beginning or close of business
- Names of the controlled substances
- Each finished form of the substances (e.g. 100 milligram tablet)
- The number of dosage units of each finished form in the commercial container (e.g. 100 tablet bottle)
- The number of commercial containers of each finished form (e.g. four 100 tablet bottles)
- Disposition of the controlled substances

In addition to the inventory of controlled substances, DEA registrants (and their agents) must also maintain a log book of the dispensation (use) of controlled substances. Every use, including administration, transfers and disposal, must be tracked in the controlled substances log book. The following information must be recorded in the log book for each event:

- Name of controlled substance
- Strength of controlled substance
- Quantity of controlled substance dispensed
- Date of dispensation event
- Name of person performing the dispensation
- Name and/or ID# for person/animal the substance was administered to

7.1.4 Transfer of Controlled Substances

Controlled substances can be transferred from one DEA registrant to another, with some restrictions. Practitioner registrants can only transfer their controlled substances to another practitioner or a pharmacy. Researcher, chemical analysis and instructional activity registrants can transfer controlled substances to each other. Controlled substances cannot be transferred from a registrant to a non-registrant, unless that non-registrant is an “agent” of a registration. Umbrella registrations can be procured from the DEA, which allows for non-agents to dispense and administer controlled substances. Obtaining an umbrella registration, however, is a long complicated process with the DEA. Notify the RLSS about any intent to establish an umbrella registration.

Transfers of Schedule I and II substances require completion of DEA Form 222 (Official Order Form). In these cases, the recipient is “ordering” the controlled substances from another researcher (the supplier). The registrant himself must sign any DEA Forms 222, unless a power of attorney has been obtained to allow someone other than the registrant to sign. If a registrant is transferring more than 5% of his/her controlled substances stock, that person needs to re-register with the DEA as a distributor. The shipment of controlled substances must adhere to Department of Transportation (DOT) regulations. For information and assistance in the shipment of controlled substances, contact the RLSS.

For transfers of controlled substances between DEA registrants within the university, both registrants must complete the RLSS “DEA Controlled Substance Intra-University Transfer Form,” found on the RLSS website, regardless of schedule. The top portion of this form must be completed by the supplier, and both this form and the DEA Form 222 (if transferring Schedule I or II controlled substances) must be sent with the controlled substance shipment to the purchaser of the DEA controlled substances. The purchaser must complete his/her section of the RLSS “DEA Controlled Substance Intra-University Transfer Form” and the DEA Form 222 (if transferring Schedule I or II controlled substances), sending the RLSS form by email, fax or mail to the RLSS and the DEA Form 222 to the DEA. The transfer of controlled substances must also be recorded in the log books of both the supplier and the purchaser of DEA controlled substances.

7.2 Hazardous Gases

Certain gases require prior approval by the RLSS before they can be ordered. These gases are controlled due to their toxicity, corrosivity or possibility for abuse. Because of the extreme hazards involved with these gases, the 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

To request a hazardous gas order, complete and submit the “Hazardous Gas Order Request Form” on the RLSS website. The RLSS will deliberate on all requests and either approve, conditionally approve, or disapprove of them, based on the laboratory’s compliance with the requirements detailed in the “Use of Hazardous Gases SOP.” The RLSS may request the assistance of technical experts in the determination of hazards.

RLSS assessments and approval are also required for orders of a replacement or backup cylinder. These assessments are usually brief and may take place in person or over the phone, to ensure proper control measures are being maintained prior to order approval.

7.3 ATF Regulated Explosive Materials

7.3.1 Explosive Materials at the UA

The 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. The University of Arizona is currently requesting determination as a government entity from the ATF in order to simplify future regulatory requirements. Until this determination is completed, the RLSS recommends that any researcher using or storing ATF-regulated explosives have the appropriate licensure with the ATF. It is the RLSS’s objective to maintain a record of all explosives 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 in the laboratory.

In addition, a laboratory’s use and/or storage of ATF-regulated explosive materials requires exception from the Arizona Revised Statutes (ARS)§ 12-781 from the University of Arizona Police Department under the University of Arizona Weapons on Campus Policy. Contact the 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 Export Control.

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 the 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 manner 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 the 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 the 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 his/her 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 whose cumulative possession of a COI exceeds the listed threshold amount may need to comply with additional security, documentation, and reporting requirements. The RLSS will inform AHs about any CFATS requirements that may apply to their laboratories.

7.5 Biological Toxins

As per the Biosafety Plan, 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 Biosafety Plan. Additional compliance parameters for the use and storage of biological toxins in a laboratory are detailed in the Biosafety Plan, which can be found on the RLSS website.

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.

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. The laboratories a minor can enter are dictated by their 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 research is directed purely toward the goals and objectives of the laboratory (rather than working as part of a recognized educational program), are considered employees. 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 can only work with hazardous chemicals and not particularly hazardous chemicals or hazardous gases. A 14 or 15 year old worker may not perform work in hazardous chemical laboratory.

7.6.2 Minors in 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 and the RLSS, is working for the betterment of him/herself, not the laboratory. In this case, the Department of Labor standards do not apply. Instead, he/she is regulated by the same Laboratory Chemical Safety Program rules as for students in a teaching laboratory. These minors may participate in appropriate/relevant experiments or processes in a laboratory environment, regardless of the hazard categories of the chemicals they work with. However, they must receive documented laboratory-specific training from their PI or laboratory supervisor and must be supervised at all times. Contact the RLSS to discuss the possibility of any minors that you wish to include in your laboratory.

7.7 Export Control

Some chemicals, data, technologies, and other laboratory-related items could be controlled for travel and export. The UA 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 under export control have specific regulatory requirements, including the screening of employees, 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).

8. Emergency Response

**IN CASE OF AN EMERGENCY:
CALL 911 to contact The University of Arizona Police Department (UAPD)
Or local Emergency Response (for satellite locations)**

The previous sections of this document have focused on preventing spills, exposures and incidents in the laboratory that may be considered “emergencies.” Unfortunately, emergencies do happen. They can be managed, however, before people are hurt or facilities and properties are damaged, as long as a laboratory is prepared.

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 the 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, etc.), as well as how to use them. This information should be covered in the laboratory-specific training provided by your 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 laboratory is required to post an evacuation map in a visible location by the fire code, and to train laboratory workers on the proper procedures in case of an evacuation. UA buildings will perform 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 the laboratory and building floor can be found on the UA Real Estate Administration 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 in each hazardous chemical laboratory. The most common type of fire extinguisher found in chemical use laboratories at the UA are ABC Fire Extinguishers. These are able to extinguish fires caused by burning normal combustibles, flammable chemicals and electronic devices. Class D fire extinguishers may also be required in a laboratory if combustible metals (e.g. magnesium, potassium and sodium) are stored or used in the laboratory. All fire extinguishers must be located so they are available to laboratory workers within seventy-five feet of travel distance. 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 his/her contiguous laboratories (i.e. separated by a single door). These kits may be purchased locally (e.g. Physicians Care All Purpose Kit) for a low price, as long as they adhere to all of the requirements detailed in the "Reference Guide to First Aid and Chemical Spill Kits" on the RLSS website.

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 his/her 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, etc.
- Neutralizing materials (sodium bicarbonate for acids and citric acid/vinegar for bases)
 - Only required if the laboratory uses or stores corrosives
- PPE (gloves, laboratory coat and splash goggles)
- Containment/waste packaging supplies

A dustpan and broom is also suggested to help in the cleanup of solid spills. 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 the kit container. 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

OSHA requires the presence of sufficient decontamination equipment for immediate emergency use when laboratory workers may be exposed to "injurious corrosive materials." The UA requires that all hazardous chemical laboratories 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 some cases, the 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 the RLSS to make this determination if a full safety shower/eyewash station is not available in your laboratory. The RLSS assessment may suggest that the use of portable eye washes, unconventional sink attachments, or other decontamination equipment may be acceptable on a temporary basis. It is important to note that if portable eye wash stations are used, they must be replaced after the manufacturer's expiration date.

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 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 requirements required for 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.
- The chemical is highly toxic, pyrophoric, self-reactive, highly oxidizing, highly water-reactive or flammable (if the spill is near an ignition source).
- The identity of the chemical is unknown.
- Multiple chemicals are involved.
- The spill/leak occurs in a public space, such as a hallway.
- The spill/leak has the potential to spread to other parts of the building, such as through the ventilation system.
- The cleanup procedures are not known or appropriate materials are unavailable.
- The cleanup requires the use of a respirator to be worn and no personnel have been trained and fit-tested for respirator use by Risk Management Services.
- The spill/leak may endanger the environment by reaching waterways or outside ground, or by going down a drain.

In the case of a major chemical spill:

1. Immediately alert others working in the area and evacuate, closing the doors to the affected area.
2. Attend to any injured or contaminated laboratory workers:
 - 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).

- b. 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.
 - c. Administer first aid as appropriate (if properly trained) and seek medical attention for the victim.
 3. If a person is injured or there is an uncontrolled fire, explosion, or leaking highly toxic 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.
 - b. Have a person knowledgeable of the area remain near the spill area and assist emergency personnel.
 4. Contact your AH and ASC to inform them of the major spill.
 5. Inform the RLSS of the major chemical spill. Injuries and exposures must be reported through RMS 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. This includes alarms from gas monitoring equipment, when there are no other indications of a gas leak. If the situation is contained, non-life threatening, and trained laboratory workers with proper cleanup equipment are on hand, laboratory workers may clean up the chemical spill themselves. 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 other laboratory personnel of the spill, as well as the AH or ASC.
2. Isolate the area, closing doors and evacuating the area if necessary.
3. If the spill involved a flammable chemical, immediately turn off any sources of ignition in the laboratory.
4. Locate the laboratory chemical spill kit and put on appropriate personal protective equipment (PPE), such as goggles, lab coat, gloves, etc.
5. Spread a neutralizing agent on spills of acids and bases (i.e. sodium bicarbonate for acids and citric acid/vinegar for bases). Collect the residue using a dust pan and broom, place in an appropriate solid waste container and dispose of as chemical waste.
6. For solid chemical spills, use a dustpan and broom to collect the majority of the spill and dispose of as solid chemical waste.
7. For neutral liquid chemicals (i.e. not acids or bases), place absorbent material (i.e. absorbent pads, spill pillows, vermiculite, etc.) on top of the spill. Once absorbed, dispose of the absorbent material as solid chemical waste.
8. Clean the spill area with water, provided the chemical does not negatively react with water.

It is suggested that the laboratory worker(s) contact the 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.

8.3 Explosion/Fire Emergency

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 the UA campus.

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, than 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.
- You know what is burning and that 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.: pull the pin, aim the fire extinguisher hose at the base of the fire, squeeze the handle to spray the contents and sweep 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 attempts to extinguish the fire do 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.

8.4 Chemical Exposure

If a laboratory worker is exposed to a hazardous chemical, they must immediately notify their ASC or AH. The AH/ASC must then inform the RLSS of the incident, as well as RMS for insurance and worker compensation purposes. If medical attention is necessary, the AH or ASC must follow the provisions defined in Section 9 and a (M)SDS must be given to the healthcare providers for each chemical the worker was 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 (M)SDS to remove the chemical from the body and decrease the risk of 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 (M)SDS for more information on possible antidotes.

8.4.1 Hazardous Chemical Inhalation

If a large amount of a hazardous chemical was inhaled, the laboratory worker should immediately move to fresh air. If the exposed laboratory worker is experiencing extreme 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, AH/ASC should call the Arizona Poison & Drug Information Center at 1-800-222-1222 for information to determine if further medical action is required.

If a fellow 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 emergency medical responders (911) or ask someone to call for you. If the laboratory worker's breathing has stopped and you have been trained in cardiopulmonary resuscitation (CPR), perform artificial respiration as you wait for the emergency response team. CPR training is available through Campus Recreation.

8.4.2 Skin Contact with Hazardous Chemicals

If hazardous chemicals come in contact with the skin, the laboratory worker should immediately notify another worker to request assistance and notify the AH/ASC. 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, the AH/ASC or another laboratory worker should call the Arizona Poison & Drug Information Center at 1-800-222-1222 to determine if further medical action is required. Contact emergency medical responders (911) if the laboratory worker continues to feel ill or if he/she experiences 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 assistance and notify the AH/ASC. Remove contact lenses (if present) and irrigate the eyes with water from an eye wash for at least 15 minutes, while holding the eyelids open and rolling around 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 evaluated by a medical professional.

8.4.4 Ingestion or Injection of Hazardous Chemicals

If hazardous chemicals are ingested or injected through a puncture wound, 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 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 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, he/she 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 Arizona Poison & Drug Information Center for information on the substance that may have entered your bloodstream to determine if further medical attention is necessary.

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 water to remove heat from the burn, and continue to flush with water for at least 15 minutes if chemicals were involved. Place 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.

9. Medical Consultations and Monitoring

The RLSS can conduct or coordinate exposure monitoring, and other institutions on campus can conduct medical consultations, when hazardous chemicals present a danger to laboratory workers. 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 assessments compare laboratory exposures to any existing exposure limits, and use these comparisons to make recommendations.

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 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. Students injured in UA 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 be provided by the Campus Occupational Health Services or by a licensed health care provider at the Banner University Medical Center. Laboratory workers not located on the Tucson main campus may utilize any licensed health care provider for consultations and medical examinations.

The RLSS will advise AH's about medical surveillance requirements from using certain OSHA-regulated chemicals outside of emergency situations. The RLSS will provide a written hazard assessment to RMS, which is required for registration into the Respiratory Protection Program.

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

The RLSS 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 RLSS is also available to conduct exposure monitoring as a preventative measure before experiments are conducted.

The RLSS will perform an initial 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 initial monitoring suggests an overexposure, the RLSS will assist the AH and laboratory workers with complying with relevant OSHA regulations. Monitoring results will be communicated with the AH and laboratory workers within 15 working days after the RLSS receives the monitoring results.

For questions regarding air quality measurements not caused by hazardous chemicals (i.e. dust, unexplained odors, carbon dioxide, etc.), contact RMS.

10. Information and Training

The RLSS and the AH of a hazardous chemical laboratory 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

Every laboratory worker has the right to access information about chemical safety, both in general and specific to the UA laboratory in which he/she works. Accessible information includes:

- The OSHA Standard 29 CFR 1910, 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
- Exposure limits for hazardous chemicals in the laboratory (PEL's for OSHA-regulated substances)
- Signs and symptoms associated with exposures to the hazardous chemicals in the laboratory
- 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

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

10.2 Training

Personnel must be trained on the following information before they may work 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 the 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 be a regular, continuing activity.

10.2.1 General Chemical Safety Training

New laboratory workers must complete the online General Laboratory Chemical Safety Training, which will be available through the RLSS User Dashboard after completing the RLSS worker invitation. The General Laboratory Chemical Safety Training explains the Laboratory Chemical Safety Program, 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 is 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, 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 read and affirm to this plan every time it is significantly updated (at least annually). Affirmations are completed and tracked using the RLSS User Dashboard; workers are also reminded of required affirmations by this system. This constant update of information and training keeps laboratory workers informed of current chemical hazard concerns, as well as changes to the UA Laboratory Chemical Safety Program.

Similar to UCHP affirmations, laboratory workers must read and affirm to the laboratory's LCHP before work begins and 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 get any questions he/she may have answered. If a laboratory worker does not feel they have received an effective and complete laboratory-specific training, he/she 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, training may be required through the RMS Respiratory Protection Program if respirators are used in the laboratory. Depending on the laboratory worker's role in the laboratory, he/she may be required to take the RMS Fire Extinguisher 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 more than two weeks must be a registered RLSS hazardous chemical worker and complete all required chemical safety training. 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.

Any laboratory visitor working in a laboratory with hazardous chemicals for less than two weeks does not need to be listed on the hazardous chemical Approval. He/she must, however, receive documented laboratory-specific training. Laboratory visitors must be supervised in the laboratory at all times by an authorized hazardous chemical user under that Approval.

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. wear special PPE when disconnecting parts of the laboratory sink). These safety orientations are not recorded by the RLSS; they should be kept by the Approval Holder in case of inspection or incident.

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 the UA are required to maintain documentation of the items listed below. To aid in the recordkeeping process, this information is maintained by the RLSS and can be accessed on the AH's 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 up-to-date hazardous chemical inventory
- A current up-to-date (M)SDS library

12. Compliance with the Laboratory Chemical Safety Program

12.1 RLSS Inspections

12.1.1 Initial Visit

Principal Investigators may register into the Laboratory Chemical Safety Program by completing the "Laboratory Chemical Safety Program Registration" form available on the RLSS website. Upon receipt of this form, the RLSS will contact the AH to schedule an initial visit. At the initial visit, a member of the RLSS staff will explain the Laboratory Chemical Safety Program and complete a baseline assessment of laboratory compliance with chemical safety regulations and any hazard control measures required to protect laboratory workers from exposure. The visiting 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 visit, the 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 the RLSS for assistance in completing the inventory or developing the LCHP

12.1.2 Annual Inspections

Formal laboratory chemical safety audits are conducted by the RLSS chemical safety staff at least once a year; all audits are planned and scheduled with the AH and/or ASC in advance. When audits are scheduled, the RLSS will provide the AH/ASC with a copy of the Chemical Safety Audit Check Guide (also provided on the RLSS website), which provides an overview of the laboratory requirements that will be reviewed during the chemical safety audit. The 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 the UA. The 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 the RLSS will typically accompany inspectors. If an individual requests access to a UA laboratory for inspection, and is not accompanied by RMS or the RLSS staff, laboratory occupants are required to verify credentials of the inspector, and contact RMS and the RLSS immediately to send a representative.

12.3 Shutdown of Dangerous Activity

The Senior Vice President for Research (SVPR) is authorized to curtail or shut down any uses of hazardous chemicals in UA laboratories considered to constitute an imminent, serious danger to health, safety, or the environment.

In the event of such curtailment or shutdown, the AH, department head, applicable dean, the 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, has been mitigated, or that the order should be rescinded for other reasons.

12.4 Close-Out Procedure for Departing Research Groups

Departmental administrators and 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 of. Typically, this occurs when an AH leaves the UA or moves to a different laboratory. A basic process flowchart can be found on the RLSS website to provide general close-out procedures. Procedures may vary by

department, but the departing research group must always work with the RLSS to ensure any hazardous chemicals left behind (legacy chemicals) are appropriately taken care of.

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 complete the "Legacy Chemicals Tracking Form" found on the RLSS website prior to their departure. Upon receiving the Legacy Chemicals Tracking Form, the RLSS will schedule a visit to assess the legacy chemicals. The RLSS will provide assistance with determining planned actions and will follow-up upon this visit to ensure the planned actions have been carried out. If the decided planned actions regarding the legacy chemicals were not completed by the date on the form and specified by the RLSS visit, the RLSS will coordinate distribution or disposal of the remaining legacy chemicals.

Ideally, this procedure will take place prior to the research group or AH leaving the UA 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 the UA and left behind hazardous chemicals in a laboratory. If you plan to leave the UA or vacate a laboratory, please notify the RLSS at 520-626-6850 to initiate close-out procedures.

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 Principal Investigator that maintains Chemical Safety approval through the 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 the 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 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 the 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 the UA and uses hazardous chemicals.

Legacy Chemicals: Chemicals that will be or have been left behind in the laboratory after a researcher leaves the University or laboratory space.

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.

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.

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 the 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: UA 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 the UA 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 the 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 the UA 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 the 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 the 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 the 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 the UA 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 the 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 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, fluorine, 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 the 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 its 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 the 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 the UA 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 the 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 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.

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; the 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. All others, including empty cylinders, must be promptly returned to the University Research Instrumentation Center (URIC) Cryogenics & Gas Facility. Compressed gas cylinders must be secured to a wall or other sturdy structure by chains, or by a cylinder stand/clam shell. 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, and be stored at least 20 feet away from oxygen gas cylinders and other oxidizing gases.

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 the 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 the 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 the UA 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 the 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 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: May catch fire: 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 pyrophorics.

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 the 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 the 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 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 the 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 the 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 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 the 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 the use of a respirator. This is especially true for chemicals that are toxic or fatal if inhaled. Contact the 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

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

Waste chemicals that present 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 the 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, he/she should call the Arizona Poison & Drug Information Center at 626-6016 for information to determine if further medical action is required. Inform the RLSS and Risk Management Services 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 the 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

Waste chemicals that present 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 the 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 the RLSS and Risk Management Services 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 the 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

Waste chemicals that present 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 the 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, he/she should get medical attention as soon as possible. Consult the chemical's SDS for more specific information on appropriate first aid. Inform the RLSS and Risk Management Services 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 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 the 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. The 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

Waste chemicals that present 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 the 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 the RLSS and Risk Management Services 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 the 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 the 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. The 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

Waste chemicals 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 the 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 the RLSS and Risk Management Services 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).

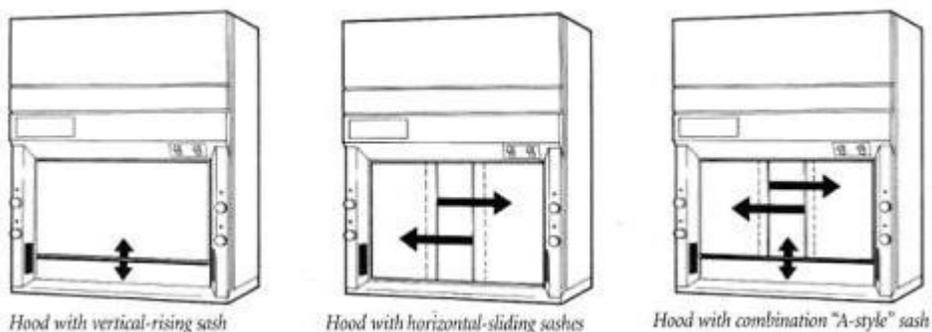
2. Scope

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 the 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 the 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 publically 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.



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 the 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 the 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.

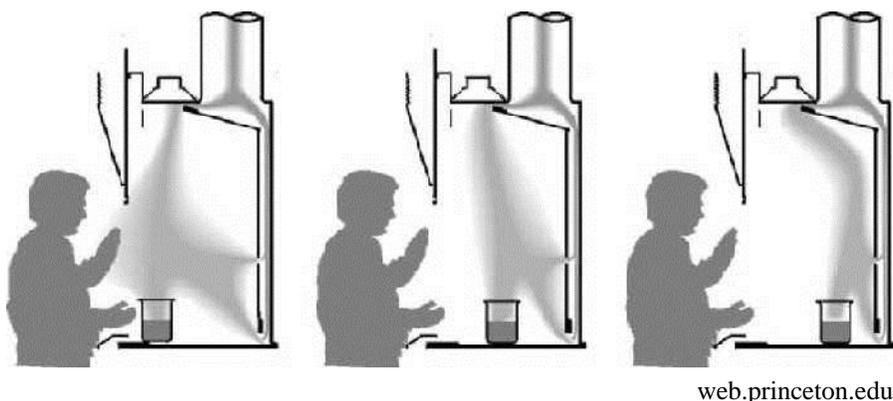
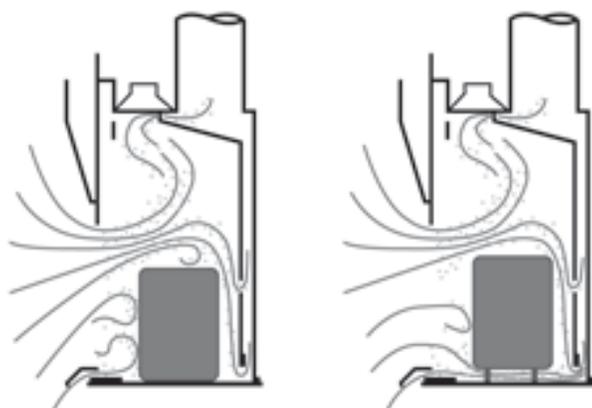


Figure 2: Containment of vapors in a chemical fume hood as a function of working distance.

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 the 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.



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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

Exposure to hazardous and particularly hazardous drugs/chemicals (i.e. carcinogens, reproductive toxins, and highly toxic chemicals) may occur when they are compounded, administered (e.g. administered in the animal's drinking water or food), and when they or their toxic metabolites are released from the animal (e.g. in the urine, feces, aspiration, etc.). Therefore, hazardous and particularly hazardous drug and chemical administration to live animals not only impacts the animal, but may also affect researchers and UAC staff handling these animals and their waste. Researchers must obtain approval from UAC before using any new hazardous 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" in animals falls under the purview of this SOP. The RLSS will perform a protocol-specific assessment 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 enter the bloodstream.
- 3.2 **Dermal Hazard:** handling animals administered creams/ointments or handling contaminated bedding can allow particularly hazardous drugs/chemicals to be absorbed across the skin.
- 3.3 **Inhalation Hazard:**
 - **Animal Exhalation Hazard:** Particularly hazardous drugs/chemicals or their toxic metabolites that are excreted by exhalation from the animal pose an inhalation hazard.
 - **Bedding Dust Hazard:** Particularly hazardous drugs/chemicals or their toxic metabolites that are excreted in the animal's urine, released into the bedding from contaminated drinking water, or otherwise adsorbed onto bedding particles can pose a particulate inhalation exposure risk. Dumping contaminated cage bedding can generate particulates with adsorbed toxic compounds.

- 3.4 **Resource Conservation and Recovery Act (RCRA) Hazard:** The waste from animals that have been administered heavy metal-containing particularly hazardous drugs/chemicals may require special disposal procedures. RLSS will inform you if your protocols generate animal waste with heavy metal concentrations that are subject to these waste disposal requirements. Table 1 shows common concentration limits for a RCRA Waste Determination.

Table 1: Common RCRA Waste Determinations

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

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.
- 4.2 **Hazard Identification:** Inform RLSS of any planned use of hazardous chemicals in research animals. This is usually 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.
- 4.3 **UAC Approval:** Obtain approval from UAC to use the proposed particularly hazardous drugs/chemicals in animals. UAC 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.
- 4.4 **Hazard Cage Card:** 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.
- 4.5 **Personal Protective Equipment:** The researcher must wear appropriate Personal Protective Equipment (PPE) when handling particularly hazardous drugs/chemicals or animals that have been administered drugs/chemicals that pose a dermal hazard:
 - Double gloves
 - Lab coats or disposable gowns (fluid-resistant if splashing is a concern))
 - Safety glasses (researchers must provide their own safety glasses)
 - Long pants
 - Close-toed shoes

Additional PPE may be required, depending on the RLSS assessment. Additional PPE could include puncture-resistant gloves, face shields, and respirators.

- 4.6 Particularly Hazardous Drug/Chemical Administration: The administration of particularly hazardous drugs/chemicals via inhalation (or in a way that creates a potential inhalation hazard) should 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 on the RLSS website.

When particularly hazardous drugs and chemicals are administered by injection, syringes and IV sets must include Luer-lock fittings to avoid injection hazards.

- 4.7 Dumping Animal Bedding: Dumping bedding that housed animals administered a “bedding dust hazard” particularly hazardous drug/chemical must be performed in a chemical fume hood or other approved ventilated enclosure. To allow for full excretion of the drugs/chemicals, these special procedures must be followed for any cage replacements between the administration “Start Date” and 72 hours after the “End Date” noted on the Hazard Cage Card. If the bedding was not dumped during this period, the first dump of bedding after this period must also be performed in an approved ventilated enclosure.

- 4.8 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, some particularly hazardous drugs/chemicals containing heavy metals may 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.

RLSS will inform the researcher and UAC when specific compound waste cannot be disposed of in a landfill.

Appendix A
UAC Hazard 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 Hazard Cage Cards from UAC husbandry staff. Follow their instructions to complete each section of the cards and to post them on appropriate animal cages.

Appendix B
Example RCRA Drug/Chemical Waste Container Content Log

RCRA Drug/Chemical Sharps / Solid Liquid Waste Container Content Log <i>Circle waste form</i>				
Date	P.I. Name	Drug/Chemical Name	Waste Description (e.g. bedding, food, etc.)	Estimated Volume of Waste
5/25/2018	Dr. X	Azoxymethane	Bedding	5 liters

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 into the Laboratory Chemical Safety Program, and have obtained approval from the Research Laboratory & Safety Services (RLSS), before ordering, acquiring and using the hazardous gases in Section 3. These gases have the potential to endanger people or property in the case of an accidental release, and are therefore heavily controlled. After registration and order approval, the safe use and storage of hazardous gases will be reviewed during annual chemical safety inspections.

3. Hazardous Gases

The gases listed in Tables 1 and 2 are considered hazardous gases in accordance with this SOP and require prior approval by the RLSS before ordering. These examples are not all inclusive; other chemicals or gases may be added depending on the hazards presented by their storage or use.

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

Compressed Gas	Chemical Formula	Highly Toxic	Pyrophoric	Carcinogenic	Reproductive Toxin	Toxic with Poor Warning Properties
Arsine	AsH ₃	X		X		X
1-3- Butadiene	C ₄ H ₆			X	X	
Carbon monoxide	CO				X	X
Cyanogen chloride	ClCN	X				X
Diborane	B ₂ H ₆	X	X			
Dichlorosilane	SiH ₂ Cl ₂		X			
Ethylene oxide	C ₂ H ₄ O			X	X	X
Fluorine	Fl ₂	X				
Germane	GeH ₄	X	X			
Hydrogen cyanide	HCN	X				
Hydrogen fluoride	HF	X				

Compressed Gas	Chemical Formula	Highly Toxic	Pyrophoric	Carcinogenic	Reproductive Toxin	Toxic with Poor Warning Properties
Hydrogen selenide	H ₂ Se	X	X			
Hydrogen sulfide	H ₂ S					X
Methyl bromide	CH ₃ Br					X
Nitric oxide	NO	X				X
Phosgene	COCl ₂	X				X
Phosphine	PH ₃	X	X			
Silane	SiH ₄		X			
Stibine	SbH ₃	X	X			X
Sulfuryl fluoride	F ₂ O ₂ S					X
Vinyl chloride	C ₂ H ₃ Cl			X		X

Table 2. Toxic and/or corrosive compressed gases.

Compressed Gas	Chemical Formula	Toxic	Corrosive
Ammonia	NH ₃		X
Boron trichloride	BCl ₃		X
Boron trifluoride	BF ₃		X
Carbonyl fluoride	CF ₂ O	X	X
Carbonyl sulfide	COS	X	X
Chlorine	Cl ₂	X	X
Cyanogen	(CN) ₂	X	
Dimethylamine	C ₂ H ₇ N		X
Hydrogen bromide	HBr		X
Hydrogen chloride	HCl		X
Methyl mercaptan	CH ₄ S	X	X
Monomethylamine	CH ₃ NH ₂		X
Nitrogen dioxide	NO ₂	X	X
Nitrosyl chloride	NOCl	X	X
Phosphorus pentafluoride	F ₅ P		X
Selenium hexafluoride	SeF ₆	X	X
Silicon hexafluoride	SiF ₆	X	X
Silicon tetrafluoride	F ₄ Si	X	X
Sulfur dioxide	SO ₂		X
Trimethylamine	C ₃ H ₉ N		X

4. Acquisition

To begin the order process of a hazardous gas, complete and submit the “Hazardous Gas Order Request Form” on the RLSS website. This form must be completed for the initial order, any re-orders, and orders of backup cylinders. After receipt of the form, the RLSS will assess the hazards presented by the gas, as well as the control measures available in the requestor’s 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. The RLSS may request the assistance of technical experts in these assessments.

Whenever possible, hazardous gases must be ordered through the University Research Instrumentation Center (URIC) Cryogenics & Gas Facility, in the smallest practical quantity, and lowest concentration for its application. Gas cylinders must be ordered with restricted flow orifices, whenever possible. After assessment, the RLSS will approve, conditionally approve, or disapprove of each request in a formal, written letter to the laboratory and URIC Cryogenics & Gas Facility. If approved (conditionally or unconditionally), the RLSS will coordinate ordering with the laboratory through URIC Cryogenics & Gas Facility or other vendor.

5. Quantity Limits

Regulatory quantity limits often apply to hazardous gases. These limits can 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, the RLSS will ensure that the new hazardous gas order will not exceed the building’s IFC storage and use limits. The IFC quantity limits for hazardous gases are summarized in Table 3. These quantities may double if the building meets certain requirements (e.g. functioning sprinkler system).

Table 3. International Fire Code 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

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

Incompatible gases (e.g. oxygen and acetylene) must be separated by a distance of not less than 20 feet, or a noncombustible partition extending not less than 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 gas cylinders 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 the RLSS. Specific requirements exist for each type of storage device, unless otherwise noted by the RLSS.

- Gas cabinets must:
 - Be constructed of not less than 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 not less than 200 feet per minute (fpm), with a minimum of 150 feet per minute at any point,
 - Have self-closing doors, limited access ports, 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 not less than 200 fpm (note – fume hoods are typically configured with a 100 fpm face velocity), with a minimum of 150 fpm at any point.
- Approved medical/research devices must:
 - Conform to all manufacturer specifications unless modifications are approved by the 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 the 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).

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 the 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.
- Excess flow control must be provided within the ventilated enclosure if the hazardous gas is carried in the piping at more than 15 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 the RLSS at 626-6850.

Hazardous gases must be purchased in returnable cylinders whenever possible. Disposal or returns to the manufacturer should be coordinated through the URIC Cryogenics & Gas Facility. Lecture bottles of gases are not returnable, and must be collected by Risk Management Services for disposal.

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 re-certified. Ventilated equipment, piping, and other systems related to the storage and use of toxic or corrosive gases must not be modified without approval by the RLSS.

10. Training and Hazard Communication

Beyond the Laboratory Chemical Safety Program's 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) and 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 SDS's, 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 warning of the gas's main hazard (e.g. Toxic, Corrosive, etc.).

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, he/she 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.