NAU
NORTHERN ARIZONA UNIVERSITY

Chemical Hygiene Plan
2024

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EMERGENCY TELEPHONE NUMBERS

University Police Department
911 for on-campus incidents

Chemical Spill or Accident
Mick Kelly 928-308-6507
Ryelan McDonough 928-679-5948
Jim Biddle 928-220-1728
After hours: call NAUPD- 911

Radiation Accident
Radiation Safety Officer, Jim Biddle 928-220-1728

Biological Accident
Biological Safety Director, Shelley Jones 480-248-0741

Ergonomics and Indoor Air Quality Concerns
Industrial Hygienist, Jim Biddle 928-220-1728

Hazardous Waste Inquiries and Pickup Requests
http://nau.edu/research/compliance/environmental-health-and-safety/

Environmental Health & Safety NON-EMERGENCY CONTACTS

AVP Sarah Ells 3-3961

Hazardous Waste Supervisor Mick Kelly 3-5903

Manager of Industrial Hygiene and Environmental Safety Jim Biddle 3-6109

Director/Biological Safety Officer/Responsible Official Shelley Jones 3-7268

Assistant Director of Occupational Safety Scott Halle 3-3961

EH&S Website: http://nau.edu/research/compliance/environmental-health-and-safety/
e-mail: NAUEHS@nau.edu
P.O. Box 4137 Flagstaff, AZ 86011

1.0 INTRODUCTION

The Northern Arizona University (NAU) Department of Environmental Health & Safety (EH&S) is dedicated to providing a safe environment for laboratory workers and students to engage in the process of scientific discovery. To accomplish this goal, EH&S will promote every reasonable precaution to remove all recognizable hazards from the laboratory environment. NAU Principle Investigators (PIs), lab managers, and faculty lab instructors are delegated the local authority and responsibility to conduct research and instruction in compliance with all applicable regulatory requirements within their area of influence.
Every PI/Lab Manager with responsibility over a hazardous chemical-use laboratory is required to register their lab with EH&S. PIs and faculty instructors that work under another PI or lab manager are not required to register independently, but instead are required to register as a member of that PI/Lab managers research group or lab. EH&S uses SciShield compliance management software to track regulatory compliance across NAU. This includes training, inspection, and inventory management requirements set forth by Federal Law.

The contents of this manual provide safety guidelines and policies for employees in all NAU laboratories, both on-campus and off-campus locations. Please note that off-campus locations may be required to provide site-specific addendums and exceptions for related safety policies, such as waste disposal options and emergency response procedures. For more specific information concerning off-campus locations, please contact EH&S.

1.1 Purpose

This Chemical Hygiene Plan (CHP) satisfies the requirements set forth by the Federal Occupational Safety and Health Administration (OSHA) standards 29 CFR 1910.1450 (Occupational Exposure to Hazardous Chemicals in Laboratories, referred to in this document as the "Lab Standard") and 29 CFR 1910.1200 ("Hazard Communication Standard"). This CHP defines the NAU Laboratory Chemical Safety Program, which has been created to protect all laboratory workers on campus from the health hazards associated with the use of hazardous chemicals in the laboratory, and to ensure that chemical exposures are kept below the limits established by OSHA, as well as the National Institute of Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH). This document is intended to establish basic safe operating practices so that students, faculty and staff may carry out their programs in a safe and healthy environment. The CHP provides specific information on hazard assessment, training requirements, exposure monitoring procedures, and accident reports.

This document is not intended to be a complete or final listing of laboratory hazards or safe practices. Because of the diverse nature of work being conducted in NAU laboratories, additional procedures or requirements may be necessary. Laboratories

that work with biological agents, radioisotopes, animals, or labs that generate chemical, biological, or radioactive wastes, must adhere to specific procedures and programs. These and other required health and safety programs and resources are referenced in the manual. Where possible, links to these resources have been provided. For information on these and other safety related policies please contact EH&S or visit our web site. Individuals having questions are urged to call the NAU Chemical Hygiene Officer (CHO). Emergency and non-emergency contact information for EH&S as well as other campus agencies is included in the front of this manual.

1.2 Scope and Availability

This CHP shall serve as the primary, general plan for all hazardous chemical use on the laboratory scale at Northern Arizona University. All persons using hazardous chemicals in a research or teaching laboratory must adhere to the requirements detailed in this document. This includes faculty, staff, students, visiting researchers, volunteers, and other personnel on the Flagstaff mountain campus, as well as satellite campuses.
The CHP must be made readily available to all NAU employees and students working in laboratories, as well as to the Assistant Secretary of Labor for Occupational Health and Safety, U.S. Department of Labor or designee upon request. A web copy of the NAU CHP can be found here: EH&S website. PIs and instructional lab managers at NAU are considered to be "employers" or "supervisory agents", and as such are required by law to implement a laboratory-specific CHP (LCHP). The LCHP must be tailored to address the unique hazards and controls in each laboratory or set of laboratories under the control of the PI or lab manager. The LCHP must be updated annually, or upon significant changes to the chemical hazards, control methods, or procedures in the laboratory. The LCHP serves to supplement the University CHP, and at no time will it contradict the guidance set forth by the University CHP (see Section 3.1.

1.3 Assignment of Responsibility

1.3.1 Chemical Hygiene Officer

The EH&S Chemical Hygiene Officer (CHO) shall be responsible for monitoring compliance and implementation of all chemical safety, storage and handling regulations for all NAU main campus facilities. This will include, but is not limited to, regulation interpretation, implementation of programs, planning reviews, facility surveys, and providing training and educational services. The CHO will have authority to ensure compliance, and to curtail any activity in laboratories deemed to present a danger to the safety of NAU students and employees.

1.3.2 Environmental Health & Safety (EH&S)

EH&S has responsibility for implementing and overseeing the Laboratory Chemical Safety Program at NAU. EH&S will collaborate with departments, faculty and PIs to achieve and maintain compliance with all applicable state and federal regulations. This general responsibility includes the following:

- Monitor compliance with and implementation of all chemical safety, storage, and handling regulations for all NAU main campus facilities.
- Eliminate or restrict any activity constituting a significant danger to the health and safety of laboratory workers, the environment, and the reputation of NAU.
- Review the NAU CHP and NAU standard operating procedures (SOPs) annually, and update as warranted.
- Provide General Laboratory Safety Training to all laboratory workers.
- Maintain a working knowledge of current health and safety rules and regulations.
- Perform laboratory hazard assessments and collaborate with PIs in the development of LCHPs and laboratory standard operating procedures (LSOPs).
- Perform announced and unannounced inspections of individual laboratories to ensure compliance with the NAU Laboratory Safety Program, and provide follow up and guidance to assist in correcting any inspection findings.
- Identify and conduct employee chemical exposure assessment monitoring to assess hazardous chemical exposures in laboratories, as mandated by 29 CFR 1910 subpart Z.
- Maintain records of all hazardous chemical laboratory inspections, exposure monitoring assessments, chemical safety trainings, OSHA injury/accident reports, and emergency responses.
- Provide guidance and technical assistance to laboratories to obtain and maintain compliance with current OSHA regulations. Monitor chemical inventories for compliance with the Chemical Facilities Anti-Terrorism Standards (CFATS).
- Maintain a hazardous chemical inventory for the Flagstaff Mountain campus
- Act as liaison on behalf of hazardous chemical-use laboratories to regulatory agencies, as well as NAU Risk Management and Facilities Services.
- Act as a notification authority in the event of a major spill or reportable accident in the laboratory.
- Perform Industrial Hygiene (IH) assessments and administer the respiratory Protection Program in laboratories.
- Safely remove and dispose of hazardous chemical waste from laboratories in accordance with state and federal regulations.
- Manage certification and inspection programs for safety and technical equipment at the Flagstaff Mountain campus.
- Provide hazard warning signs, labels, and other hazard communication requirements for laboratories.

- Aid in laboratory closures and provide advisory services in regard to proper relocation or disposal of chemicals, and decontamination of equipment.

1.3.3 Laboratory Staff

Individual laboratory workers are responsible for their own safety, and to the extent that their work practices affect their workplace, the safety of their co-workers and visitors to the laboratory. All NAU staff must demonstrate this responsibility in their actions and attitudes per NAU Personnel Safety Policy 5.03. A copy of this policy can be found at http://hr.nau.edu. It will be each laboratory worker's responsibility to:

- Attend required trainings.
- Read and follow the requirements of the CHP and LCHP.
- Follow all SOPs and LSOPs.
- Wear appropriate personal protective equipment (PPE) assigned to them.
- Adhere to prescribed safety rules and regulations.
- Follow all standard operating and emergency procedures.
- Conduct risk assessments prior to engaging in work to ensure their safety and the safety of those individuals who work around them.
- Supervise students in teaching laboratories (if a teaching assistant).
- Immediately report all accidents, near misses, and unsafe working conditions to the PI or lab manager.
- Participate in the Medical Surveillance Program, if required, and inform the PI of any work modifications ordered by a physician as a result of medical surveillance, occupational injury, or exposure.

In addition to NAU safety policies, employees conducting research on non-NAU property (field work) shall comply with all safety and emergency response policies of the host facilities. Undergraduate and Graduate student researchers and teaching assistants are considered laboratory staff for purposes of this document.

1.3.4 Principal Investigator

The Principal Investigator (PI), laboratory supervisor or manager has the responsibility for controlling hazards in her/his laboratory. The PI may assign a Laboratory Safety Coordinator (LSC) to perform these duties; however, it is the ultimate responsibility of the PI to ensure that their laboratory is compliant with the Laboratory Safety Program. PI responsibilities shall include:

- Posting of emergency contact information (see Section 3.7.1)
- Completion and communication of hazard assessments for all procedures
- Completion and maintenance of a chemical inventory (see Section 3.1)
- Establishing, or designating the establishment of lab-specific Standard Operating Procedures (SOPs) (see Section 3.6)

- Completion and annual review of a lab-specific CHP (LCHP) (see Section 3.4)
- Completion and documentation of lab-specific safety training of individuals (see section 3.5)
- Correcting work errors and dangerous conditions, including those identified in lab audits
- Implementing a culture of safety in the laboratory
- Selecting the proper personal protective equipment (PPE) for laboratory staff and ensuring that it is worn and used correctly (see Section 8.5)
- Maintaining compliance with all applicable NAU safety programs
- Reporting lab incidents and accidents (see Section 7.6.1)
- Investigating the circumstances surrounding a laboratory accident and taking steps to avoid recurrence

1.3.5 Research Departments

Research Departments shall be responsible for supporting the PI and research staff with all resources necessary to ensure safety compliance. This includes promoting applicable required safety training for PIs and staff members and allowing for time away from work for training.

Research Departments are responsible for notifying EH&S of laboratory relocations, closings, and new lab space assignments (see section 5.9). Research Departments are also required to assign a responsible party to control, maintain, and supervise common-use laboratories. This includes cold rooms, vivaria, greenhouses, and other shared spaces that are not under the direct control of a PI.

1.3.6 Northern Arizona University

NAU will aid with the compliance efforts of all staff and researchers. It will foster the attitude that safety is integral to the working and learning environment, as stated in the 2018-2025 Strategic Plan.

All university administrators have the responsibility to:

- Ensure that individuals under their management in laboratory settings have the authority to implement the CHP
- Ensure that areas under their management are in compliance with the CHP

NAU will maintain and repair the physical facilities of the laboratory, and ensure that all safety devices and engineering controls provided by the University as permanent installations (e.g. emergency eyewashes and showers, ducted fume hoods, snorkels, fire extinguishers, access and alarm systems) are in proper working order.

1.4 Annual Review

The NAU CHP will be reviewed annually from its effective date by the CHO. The CHP will be revised whenever regulatory changes mandate a revision, or when new, best-available information warrants a revision.

1.5 Employee Information and Training

Employees must have access to information and training to ensure that they are apprised of the hazards of chemicals present in the work area. Such information must be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present, prior to assignment involving new exposure situations, and when new hazardous chemicals or procedures are introduced. Employees must receive periodic refresher information and training to ensure that they are aware of the risks of exposure to hazardous chemicals in their workspace. **PIs are responsible for all site-specific training and documentation.**

1.5.1 Information

Information provided to employees by EH&S/Units/PIs/Supervisors must include:

1. Awareness of the Lab Standard and applicable laboratory requirements

2. The location and availability of the CHP as well as the LCHP and Standard Operating Procedures
3. The permissible exposure limits for OSHA regulated substances (or published exposure limits for other hazardous chemicals where there is no applicable OSHA standard) for the chemicals the employee will be using (see Section 2.2.3)
4. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory (available on Safety Data Sheets)
5. The location and availability of known reference materials on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory, including, but not limited to, Safety Data Sheets (SDS) received from the supplier
6. Emergency Procedures (see Section 6.0)

1.5.2 Training

General Chemical Hygiene Training will be provided by EH&S and may take the form of individual instruction, group seminars, online training, handout material, or any combination of the above. PI's or lab designees will provide site-specific training.

Chemical Hygiene Training provided by EH&S to employees will include:

1. Introduction to the Lab Standard
2. Applicable details of the NAU CHP, including required training, and site-specific training
3. Safety Data Sheets (SDS) and labeling
4. Chemical inventory requirements (see Section 3.4)
5. Chemical handling and storage
6. Hazardous material definitions
7. Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.)
8. The measures employees can take to protect themselves from these hazards, including specific procedures the University or Department has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.
9. Documentation of EH&S Training

Departments/PIs/Supervisors must provide site-specific training to employees and students upon hiring/enrollment and whenever a new process/hazard is introduced into the laboratory. This training must include:

1. Site-specific standard operating procedures (SOPs), including lab practices and emergency procedures
2. Specific physical and health hazards of chemicals in the work area (available on Safety Data Sheets)
3. Location of the lab-specific CHP, chemical inventory, and SDS
4. Emergency procedures
5. Documentation of the site-specific training
6. Labeling methods and resources for the lab

Documentation

General awareness training required by the CHP will be documented by EH&S. EH&S will maintain these training forms. Site-specific training must be documented and maintained by the unit/PI/supervisor and be available to the CHO and other representatives of EH&S, and members of other regulatory agencies upon request.

1.6 Record Keeping

EH&S will retain records of all employees who attend the Chemical Hygiene Training. It is required that records of specific laboratory training for individual laboratories be retained by the PI in the laboratory or within the department.

The amount of time a department/supervisor/PI chooses to retain training records is not specified in the Laboratory Standard. It is recommended that such records be retained for at least 3 years after an employee leaves a position. Ideally, training records should be retained indefinitely

2.0 HAZARD COMMUNICATION

The Northern Arizona University Laboratory Hazard Communication Program is incorporated within this CHP. Its purpose is to provide information and training to employees and students about the hazardous chemicals to which they are exposed in the course of laboratory work. This program addresses the chemical inventory, labeling, information, and training requirements set forth by the Hazard Communication Standard (29 C.F.R. § 1910.1200).

It is the responsibility of the PI or laboratory supervisor to communicate the elements of this program to students and employees and to implement it in their laboratories. NAU EH&S assists researchers in providing training and selecting proper controls (administrative, engineering and PPE) to comply with this standard.

2.1 Hazard Classification

Chemical hazards fall into one of two categories, physical and health hazards. Chemicals encountered in the laboratory setting often present both types of hazards. Many chemicals also pose an environmental hazard and must be collected by EH&S for proper disposal, regardless of whether they are otherwise considered non-hazardous.

Health hazards are defined as chemicals that pose one or more of the following hazards: acute toxicity (by any route of exposure); skin irritation or corrosion; eye irritation or serious eye damage; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific organ toxicity (single or repeated exposure) or aspiration hazard.

Physical hazards are defined as chemicals that pose the following hazards: flammable; oxidizer; self-reactive; pyrophoric; self-heating; organic peroxide; corrosive to metal; gas under pressure; contact with water emits flammable gas.

Northern Arizona University follows the OSHA classification of workplace chemicals as non-hazardous, hazardous, or particularly hazardous.

2.1.1 Non-hazardous Chemicals

Chemicals that pose neither health nor physical hazards are classified as non-hazardous. These chemicals are not required to be present on laboratory inventories; however, it is considered best practice to do so.

2.1.2 Hazardous Chemicals

Hazardous chemicals have significant evidence of posing health and physical hazards. These chemicals must be entered into laboratory inventories. Safety Data Sheets (SDS) for these chemicals must be available to laboratory workers and visitors.

2.1.3 Particularly Hazardous Chemicals

The Laboratory standard (29 C.F.R. § 1910.1450) defines particularly hazardous chemicals as select carcinogens, reproductive toxins, and substances with a high degree of acute toxicity. These chemicals must always be accounted for in the laboratory inventory. Hard copies of the SDS must be kept in the laboratory. As particularly hazardous substances pose a higher risk to laboratory workers than hazardous chemicals, special attention must be given to their use in the development of the LCHP, including the establishment of a designated area for handling them. A designated area can be a fume hood, lab bench, or even an entire laboratory.

Select carcinogens are chemicals listed by OSHA as carcinogens, by the National Toxicology Program (NTP) as "known to be carcinogens" and by the International Agency for Research on Cancer (IARC) as Group 1 carcinogens. Also included are chemicals or processes listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP and that cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

1. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3
2. After repeated skin application of less than 300 mg/kg of body weight per week
3. After oral dosages of less than 50 mg/kg of body weight per day

OSHA; IARC Group 1, 2A, and 2B, as well as the NTP carcinogens, are listed in Appendix B.

Reproductive toxins are defined as any chemical that affects the reproductive capabilities of males or females, including chromosomal damage (mutagens) and effects on fetuses (teratogens). Information on reproductive effects will be listed on the SDS.

Chemicals with a high degree of acute and chronic toxicity are not defined in the Laboratory Standard. Therefore, the OSHA Hazard Communication definition of a highly toxic chemical will be used. Chemicals with a high degree of acute toxicity are chemicals that have a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each. The LD_{50} is the dose at which a lethal response is observed in 50% of the test animals.

2.2 Hazard Determination

Hazard information for commercially acquired chemicals is provided by manufacturers and distributors in the form of Safety Data Sheets (SDS), formerly known as material safety data sheets (MSDS). The SDS is the primary means of identifying the hazards posed by any particular chemical; additional information can be found in the literature or, in case of emergencies, by contacting the Arizona Poison and Drug Information Center (APDIC) at 1-800-222-1222.

2.2.1 Mixtures of Hazardous Chemicals

If a mixture of hazardous chemicals is formulated in the laboratory and has not been tested for potential hazards, laboratory workers must label and use appropriate controls for the combination of hazards presented by each component of the mixture. In the absence of data, workers should assume that the mixture is more toxic than the most toxic component of the mixture.

2.2.2 Newly Synthesized Chemicals

As the hazards of novel chemicals are usually unknown, all newly synthesized chemicals shall be considered hazardous unless they have been proven otherwise by the criteria specified in 29 C.F.R. § 1910.1200 appendix A.

2.3 Hazard Communication

Northern Arizona University has adopted the Globally Harmonized System (GHS) for the classification of hazardous chemicals, per the OSHA Hazard Communication Standard (29 C.F.R. § 1910.1200). Chemicals are classified by manufacturers according to GHS hazard statements, which explain the specific type of hazards posed by each chemical. Each hazard is categorized by relative severity, with Category 1 being the most severe and Category 4 being the least severe hazard. GHS also requires a set of precautionary statements, which list standard control measures for each chemical.

Nine pictograms are used by GHS to quickly convey the hazards posed by chemicals in the laboratory. The pictograms are shown in Figure 1.

 **Irritant**- May cause eye and skin irritation (redness, rash), skin sensitization, narcotic and other less serious toxic effects	 **Health hazard**- May cause serious and prolonged health effects on short- or long-term exposure. Includes aspiration hazards and respiratory sensitizers. Includes carcinogens, mutagens, target organ toxicity, and reproductive toxicity	 **Toxic**- Substance which may cause life threatening effects even in small amounts and with short exposure
 **Corrosive**- Can cause serious skin damage and irreversible eye damage. Corrosive to metals	 **Flammable**- Liquids, solids, aerosols, and gases can burn if exposed to ignition source and/or heat. Can give off flammable vapors. Includes pyrophoric materials	 **Oxidizer**- Can burn without air, can intensify fire by providing oxygen to combustible materials
 **Environmental**- Toxic to aquatic organisms. Acute and chronic hazards to aquatic environments, environmental toxicity	 **Explosive**- May explode if exposed to shock, friction, heat, and fire. Includes organic peroxides, self-reactive materials	 **Compressed gas**- gases under pressure, includes liquefied gases and cryogenic liquids. Can pose asphyxiation hazard. Cylinder can pose explosion/projectile hazard if damaged

Figure 1. GHS pictograms

3.0 LABORATORY REQUIREMENTS

3.1 Hazardous Chemical Inventory

A Hazardous chemical inventory must be maintained for every laboratory on campus. The inventory must include the following items:

- CAS number (if applicable)
- Chemical name, as shown in Section 1.1 of the SDS
- Maximum amount, including units (e.g. g, kg, mL, L) present in the lab at any given time
- If the lab is a shared space, name of PI responsible for the chemical

If the lab has several storage locations, it is encouraged that a column listing location of the chemical within the lab is included.

Non-hazardous chemicals are not required to be present on the inventory, but it is encouraged as being best practice. Consumer goods used for their normal purposes (e.g. glass cleaner, White-out) are not required to be present on the inventory. However, consumer goods used in the course of research (e.g. household bleach used as an oxidizer) must be accounted for in the inventory.

The hazardous chemical inventory should be reviewed quarterly and updated as needed.

3.2 Safety Data Sheets (SDS)

Safety Data Sheets for all hazardous chemicals in the lab must be readily accessible to students and employees at all times. EH&S encourages that SDS are kept in the lab as paper copies, but electronic copies are acceptable if the following conditions are met:

- The chemical is not a particularly hazardous substance
- The lab has a desktop computer which can be accessed by all lab members
- The SDS are kept as files on the computer (internet searches for SDS are not acceptable)
- The computer is linked to a functioning printer to which all lab members have access
- Retrieval and printing of SDS can occur within 5 minutes

It is strongly encouraged that research students create binders for their projects that contain hard copies of SDS for the chemicals that will be employed in the course of their research. These binders should be unique to each project, and be kept on hand as the student(s) engage in their work.

Legacy chemicals that were received prior to 2015 must have the MSDS replaced with an equivalent SDS. If a replacement SDS is not available from the original supplier, it is acceptable to obtain one from a different source, provided that the new SDS is for the identical product/substance. The original suppliers contact information, if available, must be retained along with the new SDS. In the event that a product has been discontinued or is otherwise no longer available for purchase, contact EH&S for consultation regarding the replacement of MSDS with SDS.

SDS are not required for consumer products that are present in the laboratory, provided that those products are used as intended, in normal quantities and at a similar frequency to regular office/household use. If a consumer product is used at greater than normal frequency, or for off-label purposes (e.g. household bleach as a solvent or reagent), the SDS for that product is required.

The EH&S website (http://nau.edu/research/compliance/environmental-health-and-safety/ contains links to SDS resources. If you wish to review an SDS and cannot find the document, contact your PI or supervisor.

3.2.1 Safety Data Sheets (SDS) for Newly Synthesized (Novel) Chemicals

If a novel chemical is being transferred to another researcher outside of the lab, or to a different institution for any purpose, an SDS must be generated for that chemical. The SDS must contain all known physical and chemical properties, hazards, and regulatory information as well as contact information for the PI. Contact EH&S for assistance with developing an SDS for novel chemicals.

3.3 Chemical Labeling

3.3.1 Labeling Primary Containers

Labels on containers received from chemical manufacturers must not be removed or defaced. If labels deteriorate or fall off in the course of normal operations, a Global Harmonized System (GHS) compliant label must be generated and affixed to the container. The label may be printed or written out by hand, but must contain the following elements:

1. Product Identifier: The chemical name must match the product name in Section 1.1 of the SDS
2. Signal Word: Either “Warning” or “Danger”, as given in Section 2.2 of the SDS
3. Hazard Statements: As listed in Section 2.2 of the SDS.
4. Precautionary Statements: As listed in Section 2.2 of the SDS
5. Supplier Identification: Contact information for the supplier of the product, as listed in Section 1.3 of the SDS
6. Pictograms: As given in Section 2.2 of the SDS

A GHS compliant label is shown in Figure 2.

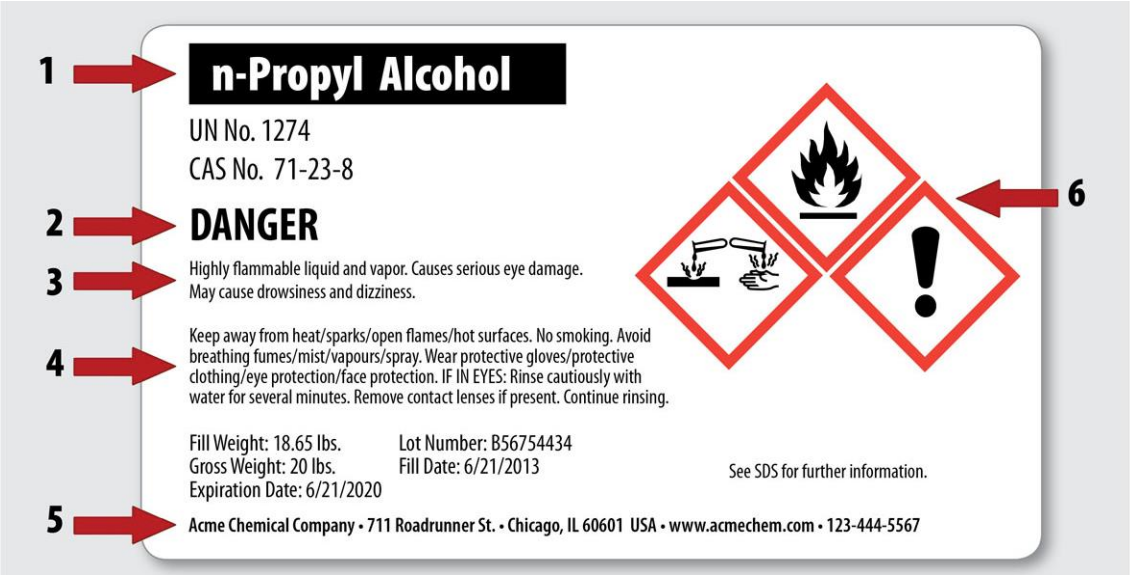


Figure 2: Training Sample Label Courtesy of Weber Packing Solutions

Contact EH&S for assistance with printing GHS compliant labels.

3.3.2 Labeling Secondary Containers of Non-Hazardous Chemicals

Non-hazardous chemicals must be labeled with the full chemical name so as to distinguish them from hazardous materials (e.g. DI water, brine, agarose, etc.). Further hazard communication is not required; however, it is encouraged that the words “non-hazardous” be added to the label in the case of buffers and other solutions that are not widely used on campus.

Abbreviations may be used if a list of abbreviations is posted within clear view of the storage area for the chemical. Contact EH&S for a list of abbreviations template.

3.3.3 Labeling Secondary Containers of Hazardous Chemicals

Hazardous chemicals that are transferred outside of the original manufacturer's container must be labeled with the following:

- Full chemical name. Abbreviations are acceptable, provided that an approved list of abbreviations is posted within clear view of the storage area for the chemical. Contact EH&S for a list of abbreviations template
- GHS compatible hazard communication. This is most easily accomplished by use of GHS pictogram stickers, but it is acceptable to write out the hazard longhand (e.g. toxic, health hazard, irritant, flammable, corrosive, etc.)

This requirement applies to chemicals that are directly transferred to a new container, as well as prepared solutions. In the case of solutions, every effort should be made to accurately convey the hazard of the final concentration of the solution (1M hydrochloric acid does not pose the same hazards as 12M hydrochloric acid). In the absence of an equivalent SDS for a prepared solution, it is acceptable to over-classify the hazard after consultation with EH&S.

Chemical containers that are too small for GHS compliant labeling (e.g. vials, ampules, etc.) must be stored in a box or tray that meets the requirements listed above. These containers must be labeled with a chemical formula or other abbreviation to indicate their contents, and be returned to the GHS compliant box or tray at the end of the work session. In the case of instructional labs, the lab manual should contain the necessary information to serve as a list of abbreviations.

Consumer products that are stored outside of the original product container must be labeled with the full product name and appropriate hazard communication.

3.3.4 Labeling Day Use Containers

Portable containers into which hazardous chemicals are transferred from labeled containers for immediate use (e.g. beakers, Erlenmeyer flasks, vials, etc.) and which remain under the control of the person who transferred it, within the work shift in which it was transferred, are exempt from labeling. However, it is strongly recommended that a temporary label identifying the chemical and its primary hazard be affixed to the container as a prudent practice.

3.3.5 Labeling Newly Synthesized (Novel) Chemicals

The PI for the laboratory bears responsibility for ensuring that newly synthesized (novel) chemicals are labeled with the appropriate hazard communication. Either the full chemical name or structure must be present on the container, as well as any known hazard information. Novel chemicals in solution must be labeled with the identity and hazards of the solvent as well. If laboratory notebooks are referred to on the container, the notebook must be in the room and available for reference. As the hazards of novel chemicals are usually unknown, the label must reflect that the substance has not been tested for hazards, and that the substance should be assumed to be hazardous unless proven otherwise. It is encouraged that sample refrigerators/freezers are affixed with signage to this effect.

3.3.6 Labeling Peroxide Forming Chemicals

Peroxidizable chemicals are listed in Appendix F and must be labeled with:

- Date Received
- Date Opened
- Date Tested
- Test Results

3.3.7 Labeling Stationary Containers

Stationary process containers such as tanks may be identified with signs, placards, process sheets, batch tickets or other written materials instead of actually affixing labels to process containers. The sign or placard must convey the same information that a label would and be visible to employees throughout the work shift.

3.3.8 Labeling Waste Containers

All hazardous chemical waste must be segregated and labeled according to the EH&S Hazardous Waste Management Rules (See Appendix G). Refer to section 5.14 for more information. **For specific information regarding labeling hazardous wastes, contact EH&S.**

3.4 Site-Specific Chemical Hygiene Plan (LCHP)

Individual laboratories at Northern Arizona University are required by law to create a site-specific CHP (LCHP). This responsibility belongs to the PI or her/his designee for each lab. The LCHP can be considered supplemental to the NAU CHP and enables the PI to address hazards unique to their laboratory. An LCHP template is available at the EH&S website. EH&S staff are available for consultation in the development of LCHPs.

3.5 Site-Specific Training

The Lab Standard requires site-specific training for all laboratory employees in addition to the Chemical Hygiene Training offered by EH&S. This training is to be provided by the PI or their designated proxy. A laboratory specific training template/checklist is available at the EH&S website. Topics to be covered in site-specific training include, but are not necessarily limited to:

1. Awareness of the NAU CHP/Lab Manual
2. Awareness and overview of the lab-specific CHP
3. Chemicals that will be used in the laboratory, their hazards, safe use requirements, methods of detection
4. PPE Hazard Assessment (See Section 9.5)
5. Awareness and location of the SDS collection
6. Awareness and location of the Chemical Inventory
7. Awareness of labeling systems
8. Awareness and location of all lab-specific Standard Operating Procedures (SOPs)
9. Location of eyewash/and or safety shower and means of operation
10. Location of spill kit and spill procedures
11. Emergency procedures for chemical, fire, exposure and injury incidents

Documentation of site-specific training is crucial. Training records are required to be kept for a minimum of three years after matriculation or termination of employment, although it is best practice to retain records indefinitely. Records may be kept as hard copies in the lab. It is encouraged that they are also uploaded to the labs SciShield profile page.

3.6 Lab-Specific SOPs

Where the scope of hazards is not adequately addressed by this general document, units and/or PIs must develop laboratory specific written standard operating procedures (LSOPs) for work area specific operations. Examples of processes that require an LSOP include, but are not limited to distillation, electrophoresis, extractions and tissue digestions. LSOPs must be provided to all affected laboratory employees. Several SOPs for work commonly conducted in laboratories are available through EH&S (EH&S website). These SOPs may be adopted as LSOPs

providing they account for the same processes. An LSOP template is available at the EH&S website.

3.7 Signs and Information

Labels and warning signs must alert employees to potentially hazardous materials and allow personnel that are unfamiliar with the laboratory space to identify hazardous chemical use and storage areas, safety and emergency equipment, exits, and aid emergency response personnel. When applying labeling and signage outside and within a laboratory, consider how to effectively communicate hazards not only to laboratory and building staff, but also for emergency personnel such as Fire, EMS and Police.

3.7.1 Emergency Contact Posting

An Emergency Contact Posting must be posted at all of the entrances to the lab to identify the categories of potentially hazardous materials that may be found in the lab at any given time. Hazard warnings contained on this posting identify the potential chemical, biological or physical hazards that may be present in the laboratory. The posting is completed by EH&S staff, based on information provided by the PI or her/his designee, and provided to the laboratory.

The Emergency Contact Posting must also include an emergency call list for individuals responsible for the laboratory. Two individuals must be identified who can be reached by the NAU Police Department (NAU-PD), EH&S, or other emergency responders in the event of an emergency. If you do not wish to have home phone numbers posted at the lab, you may list the NAU Police number (3-3000) as long as you have provided a 24-hour number to NAU Police. The Emergency Contact Posting will need to be updated as needed when lab staff changes.

3.7.2 Generic Signs/Postings

Every laboratory shall have the following signs visibly posted:

1. Emergency Contact Posting (see Section 3.6.1)
2. The location of SDS's for all hazardous chemicals used in the laboratory
3. If a laboratory has 10 gallons or more of a flammable liquid, the main doorway to the lab shall have a flammable liquid sticker visibly posted on it. This is an aid to fire response personnel.
4. NAU Emergency Procedures Manual

3.7.3 Restricted Access and Designated Areas

Facilities containing certain hazards must have warning signs posted at the designated area of the laboratory where the hazard exists, and at the entranceway to the laboratory (on the Emergency Contact Posting). Any areas placarded as such

are restricted access, designated areas and have certain standards regarding training and use by employees. Such hazards include:

- Class A carcinogens
- Animal containment
- HIV and HBV research laboratories and production facilities*
- Biological agents that require Biosafety Level 2 or higher*
- Radioisotopes*
- X-rays*
- Class IIIB and IV Lasers*

Other chemical hazards of concern can be dealt with on a case-by-case basis, with consultation from EH&S.

*Please contact the EH&S Biosafety Officer or Radiation Safety Officer for requirements on these items.

3.8 NAU Emergency Procedures Manual

The NAU Emergency Procedures Manual is available online: NAU Office of Emergency Management. This manual must be printed (preferably on red paper for uniformity) and posted in a prominent area of the lab.

3.9 Chemical Storage Areas

Chemicals must be stored according to compatibility (see Appendix E) as designated by hazard classes, and storage areas must be labeled. Particular hazardous chemicals must be stored and handled with extreme care. **When ordering chemicals that are unfamiliar, review the SDS before purchase so that use and storage guidelines are understood.** Assure that the following areas are labeled and chemicals are stored appropriately:

1. Carcinogens
2. Corrosives
3. Flammable Liquids
4. Flammable Solids
5. Oxidizers
6. Perchloric Acid
7. Biohazardous Agents*
8. Radioisotopes*
9. Ethidium Bromide

*Please contact the EH&S Biosafety Officer or Radiation Safety Officer for information.

3.10 Spill Kits

NAU requires all labs to maintain spill control materials in the event of a chemical spill. Commercial spill kits including instructions, absorbents, neutralizers, and protective equipment can be purchased through a commercial laboratory supply company. Spill kit contents must be site- specific and based on chemicals stored in your area (e.g. mercury, acids). A large centrally located spill kit may be used for a suite of labs provided it is placed near the area(s) with the highest potential for spills, is always available to staff, and staff has been informed of the location of the spill kit. Spill kits are purchased at the department level. See Section 9.2 for more detail on spill kit purchasing, recommendations and use.

4.0 REDUCING EXPOSURE

4.1 Permissible Exposure Limits

The following sources have established lists of hazardous chemicals and their permissible exposure limits based on substantiated tests:

1. OSHA, 29 CFR 1910.1000 Subpart Z, Toxic and Hazardous Substances and Appendices A and B of OSHA 29 CFR 1910.1200
2. American Conference of Governmental Industrial Hygienists (ACGIH), "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment," (latest edition)

The Laboratory Standard requires that employers, for laboratory use of substances regulated by OSHA occupational health standards, assure that employees' exposures do not exceed the Permissible Exposure Limits (PELs). The PELs represent Time Weighted Averages (TWA's) in parts per million (ppm) or milligrams of substance per cubic meter of air (mg/m3). The TWA represents the ratio between exposure and length of work shift.

The American Conference of Governmental Industrial Hygienists (ACGIH) has established Threshold Limit Values (TLV's), which are TWA values similar to PEL's. The TLV's are in some cases lower than the PELs. To keep employee exposures as low as reasonably achievable, employers will be expected to uphold the lowest exposure limit, be it a PEL or a TLV. Good laboratory practices, which make use of administrative and engineering controls, combined with proper personal protective equipment (PPE) should result in zero exposure to both federally regulated and unregulated hazardous chemicals.

4.2 Employee Exposure Determination and Monitoring

The need to determine employee exposure to hazardous substances is driven by several factors. PIs/Supervisors must contact EH&S to perform employee exposure monitoring under the following circumstances:

1. Initial monitoring must be performed if there is reason to believe employee exposure levels routinely exceed the action level, or Permissible Exposure Limit (PEL).
2. Periodic monitoring must be performed when initial monitoring reveals an exposure. The employer must comply with exposure monitoring provisions of the relevant standard.
3. Some chemical-specific federal standards require specific monitoring schedules.

Monitoring can be terminated in accordance with the relevant standard. Employers must notify the employee of the monitoring results within 15 working days after receipt of monitoring results. The results must be either individually distributed in writing or posted in a location accessible to all affected employees.

EH&S is available to consult on air quality issues caused by unregulated substances including but not limited to dust, mold, allergens, vehicle exhaust, and unexplained odors.

4.2.1 Medical Consultations and Examinations

The Lab Standard requires that NAU provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary under the following circumstances:

1. When an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee must be provided an opportunity to receive an appropriate examination.
2. Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the Permissible Exposure Limit) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.
3. Whenever an event takes place in the work area, such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultations shall be for the purpose of determining the need for a medical examination.

All medical consultations and examinations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay and at a reasonable time and place.

In the event of an employee exposure, the employer shall provide the following information to the physician:

1. The identity of the hazardous chemical(s) to which the employee may have been exposed.
2. A description of the conditions surrounding the exposure, including available quantitative exposure data.
3. A description of the signs and symptoms of exposure that the employee is experiencing, if any.

The employer shall obtain a written opinion from the examining including the following:

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

The written opinion of the physician shall not reveal specific finding of diagnoses unrelated to occupational exposure.

4.3 Pregnancy Counseling

EH&S strongly recommends that any pregnant person, or person that plans on becoming pregnant, that works with or is exposed to hazardous chemicals in the course of their job duties, obtain detailed information on the hazards of the chemicals in their workplace. EH&S is available to provide basic information on the safe use of chemicals during pregnancy, and to connect the employee with the appropriate resources on campus. The Arizona Poison and Drug Information Center (APDIC) can provide information on the risks of using specific hazardous chemicals during pregnancy. Board-certified genetic counselors are available for consultation at 1-888-285-3410.

4.4 Control Measures

The Lab Standard requires that the PI/Lab Supervisor implement control measures to reduce employee exposure to hazardous chemicals. The Occupational Safety and Health Administration (OSHA) requires that Engineering Controls be implemented

prior to other control measures when possible. The three types of control measures are:

1. **Engineering Controls:** methods of controlling employee exposures by modifying the source or reducing the quantity of contaminants released into the work environment. Examples include fume hoods and biosafety cabinets.
2. **Administrative Controls:** methods of controlling employee exposures to contaminants by job rotation, work assignment or time periods away from contaminant. Examples include Standard Operating Procedures, Chemical Hygiene Plans and Safety Manuals.
3. **Personal Protective Equipment (PPE):** personal safety equipment designed for secondary employee protection from hazardous chemicals. Examples include respirators, chemical-specific gloves and lab coats.

As a general prudent practice regarding air contaminants, Federal Safety Standards state that engineering controls and administrative controls shall first be determined and implemented when feasible. When such controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in the rule.

Control measures must be employed when the following circumstances are met:

1. An employee uses hazardous chemicals
2. Employee exposures exceed the action level (or, in the absence of an action level, the Permissible Exposure Limit, the published exposure limit or the Threshold Limit Value)
3. Upon addition of new chemicals or changes in procedures

Other situations must be dealt with on a case-by-case basis. Please consult EH&S for assistance in establishing control measures.

The following general control measures are recommended for use in most situations requiring the use of hazardous chemicals:

1. Use the following primary methods for detecting exposures:
   - Determine the source of exposure.
   - Determine the path the contaminant follows to reach the employee.
   - Determine the employee's work pattern and use of PPE.
   - Change one or more of the above pathways to reduce or eliminate exposure.

2. Substitute less harmful chemicals for more harmful chemicals whenever possible.

3. Change or alter processes to minimize exposure.

4. Isolate or enclose a process or work operation to reduce the number of employees exposed (for example, use a fume hood).
5. Use wet methods to reduce the generation of dust.
6. Use local exhaust ventilation (hoods or flexible ducts/trunks) at point of generation or dispersion of contaminants and use dilution (general) ventilation to reduce air contaminants.
7. Practice good housekeeping procedures to reduce unnecessary exposures.
8. Use training and education as primary administrative controls for reducing exposures.
9. Use special control methods such as shielding and continuous monitoring devices to control exposures in special situations.

4.5 Personal Protective and Safety Equipment

Maintaining a safe laboratory environment is the responsibility of the PI, but all employees play a role in observing safety guidelines. Personal protective devices and safety equipment must be provided to all employees under the appropriate circumstances and employees have the responsibility of properly using such equipment (see Section 8.5).

The SDS will provide some information on the personal protective equipment and safety procedures recommended for a given chemical, though the SDS may not provide sufficient information concerning the specific type of safety equipment required (for example, it may say "use gloves" but not list the best glove to use).

OSHA has adopted the American National Standards Institute (ANSI) consensus standards for eye protection and emergency shower and eyewash facilities.

4.6 Standard Safe Handling and Storage Requirements

The Lab Standard requires that chemicals be stored and handled according to the manufacturers' instructions and according to chemical compatibility. Additional requirements are set forth by agencies such as the NFPA (National Fire Protection Association).

A chemical manufacturer's label will provide the initial information on the handling of any substance. The SDS, which must accompany the packaging, will also provide details on proper storage and handling. Storage and handling directions found on the label must be followed.

5.0 GENERAL LABORATORY SAFETY GUIDELINES

This section includes general lab safety guidelines developed by EH&S that are relevant to safety and health considerations when laboratory work involves the use of hazardous chemicals. **The safety guidelines in this document specify minimum requirements and recommendations.**

5.1 General Safety Principles

The following guidelines have been established to minimize hazards and to maintain basic safety in the laboratory.

1. Substitute hazardous products with less hazardous products when possible.
2. Examine the known hazards associated with the materials being used. Never assume all hazards have been identified. Carefully read the label before using an unfamiliar chemical. When appropriate, review the Safety Data Sheet (SDS) for special handling information. Determine the potential hazards and use appropriate safety precautions before beginning any new operation.
3. Be familiar with the location of emergency equipment - fire alarms, fire extinguishers, emergency eyewash and shower stations and know the appropriate emergency response procedures.
4. Avoid distracting or startling other workers when they are handling hazardous chemicals.
5. Use equipment and hazardous chemicals only for their intended purposes.
6. Always be alert to unsafe conditions and actions and call attention to them so that corrective action can be taken as quickly as possible.
7. Wear eye and face protection when appropriate.
8. Always inspect equipment for leaks, tears and other damage before handling a hazardous chemical. This includes fume hoods, gloves, goggles, etc.
9. DO NOT taste or smell hazardous chemicals.

5.2 Health and Hygiene

The following guidelines detail prudent practices with regard to health and hygiene in a laboratory.

5.2.1 Clothing and Footwear

Clothing that is extremely loose or tight fitting must be avoided. Overly tight clothes, such as leggings and body suits, are not recommended, as any spilled material will be held next to the skin by these garments. Overly loose clothing, long necklaces,

ties, or scarves can get caught in equipment or knock over work materials. Personal clothing that is worn home must be covered by protective apparel when working with hazardous chemicals. Lab coats or other gowning must be worn when working in BSL-2 labs, with radioisotopes, or when personal clothing leaves skin exposed. Lab coats and gowning must not be taken home for laundering. Various laboratories and clinical areas establish contracts with outside laundry services. Contact NAU Purchasing for more information.

Long hair must be tied back so it does not come in contact with chemicals, biological or radiological substances or if there is a possibility of becoming entangled in equipment. Jewelry must not be worn under disposable gloves or when working on equipment.
Full coverage shoes that are non-skid and constructed of sturdy material must be worn at all times while in the lab.

The following practices have been established to protect laboratory employees from health risks associated with the use of hazardous chemicals:

A. Avoid direct contact with any hazardous chemical. Know the types of protective equipment available and use the proper type for each job.
B. Confine long hair and loose clothing and always wear fully covering footwear
C. Do not mouth pipette.
D. Use appropriate safety equipment (e.g. fume hoods) whenever exposure to gases, vapors or aerosols is suspected and ensure exhaust facilities are working properly.
E. Wash thoroughly with soap and water after handling chemicals, before leaving the laboratory and before eating or drinking.
F. Replace personal protective equipment as appropriate.
G. Ensure that laboratory employees are familiar with the symptoms of exposure for laboratory specific chemicals and the precautions necessary to prevent exposure.

5.2.2 Food and Drink in the Laboratory

Food and drink cannot be stored or consumed in areas where chemical, biological or radioactive substances are being used or stored. Break rooms or lunchrooms must be used where available. Food and drink may only be consumed in prescribed and clearly designated areas, away from lab equipment and potentially contaminated airflow. Transporting samples and chemicals is not permitted through the designated area. Equipment (e.g. microwaves), glassware or utensils that have been used for laboratory operations must never be utilized to prepare or consume food. Laboratory refrigerators and cold rooms may not be used for the storage of foods. Separate, clearly labeled appliances must be used. Sinks and drain boards used for washing food utensils must not be used for research purposes. Ice made in ice machines used to provide lab ice cannot be used for human consumption.

5.2.3 Smoking

Smoking is not allowed on NAU campus. The use of designated smoking areas is required. See the NAU Smoking Policy 5.04 (www.hr.nau.edu) for more information.

5.2.4 Cross Contamination Prevention

Personal protective equipment (gloves, lab coats, etc.) is not permitted in public areas of the building such as restrooms, offices or cafeterias. In an effort to eliminate possible exposure or contamination of building fixtures and equipment, gloves shall be removed when leaving the lab. To transfer specimens or chemicals from one lab to another, use one gloved hand to handle the cart or container. The ungloved hand can be used to open doors, push elevator buttons, etc. Double containment of the substance is also required during transport for spill control.

When working with chemical, biological or radioactive substances, hands shall be washed often, especially after gloves have been removed and before leaving the lab. Lip balm, cosmetics, or contact lenses must not be applied or handled in the lab. Solutions must not be pipetted or siphoned by mouth. Only mechanical pipette and siphoning aids will be used.

5.3 Ergonomics

Laboratory workers are at risk for repetitive motion injuries during routine laboratory procedures such as pipetting, working at microscopes and containment cabinets (biosafety cabinets or fume hoods), operating microtomes, using cell counters and video display terminals. By becoming familiar with how to control laboratory ergonomic risk factors, laboratory workers can improve comfort and productivity while lowering chances for occupational injuries. Please contact EH&S to address ergonomic concerns.

5.4 Physical Hazards

Physical hazards and poor housekeeping practices may put staff and visitors at risk of injury. Lab staff must correct or report any hazards found in the lab. Physical hazards or housekeeping issues observed outside of the lab must be reported to the appropriate maintenance division.

Materials that present a physical hazard can be safely used if the specific hazard(s) are understood. If appropriate precautions are not taken, personal injury or property damage may occur. Additionally, certain chemicals cannot be safely mixed or stored with other chemicals because of the danger of a violent reaction or a reaction that generates toxic gas. See Appendix E for a table of incompatible chemicals.

Trip Hazards
Trip hazards such as electrical or computer cords across floors, excess storage in walkways, etc. must be minimized. Irregular, bumpy or loose flooring must be reported to Facilities Services. Aisles, hallways and stairways must not be used for storage areas. Avoid excessive overhead storage. Shelves must be of sturdy construction, leveled, and if possible, attached to walls or cabinets so they do not tip. Do not overload shelves.

Spills and Cleanup
To minimize slips, falls, or other potential hazards, spills must be attended to immediately, no matter what the substance may be. Clean-ups must follow the completion of any operation or be done at the end of the day. Laboratory-specific hazard assessment and pre-planning will assist laboratory employees determining the nature of
a chemical spill. For specific instructions on chemical spill response, see Section 6.4.

5.5 Housekeeping

Safety follows from good housekeeping practices. Use the following guidelines to maintain an orderly laboratory:

A. Keep work areas clean and uncluttered with chemicals and equipment. Clean work areas upon completion of an operation or at the end of each workday, including floors.
B. Dispose of waste per the NAU Hazardous Waste Management Rules (Appendix G).
C. A separate waste receptacle must be designated for non-contaminated glass. Follow guidelines established in the EH&S Guidelines for the Disposal of Contaminated Glass.
D. Clean spills immediately and thoroughly, as per the guidelines established in Section 6.4 of this document. Ensure a chemical spill kit is available and that employees know how to use it.
E. Do not block exits, emergency equipment such as eyewashes and showers, or controls or use hallways and stairways as storage areas.
F. Assure hazardous chemicals are properly segregated into compatible categories (see Appendix E of this document).

5.6 Chemical Handling and Storage

At NAU, the decision to use a hazardous chemical includes a commitment to handle and use the chemical properly from initial receipt to disposal. Adhere to the following guidelines to assure proper handling.

A. Provide/obtain information on proper handling, storage and disposal of hazardous chemicals and assure related SDS are available to all laboratory employees prior to the use of the chemical.

B. Always purchase the minimum amount necessary to maintain operations.
C. Do not accept chemical containers with missing or defaced labels or that violate appropriate packaging regulations.
D. Only use chemicals that can be adequately controlled/contained by the laboratory's ventilation system.
E. Do not store hazardous liquid chemicals above a 5-foot level and do not store large bottles more than two feet from floor level.
F. Segregate chemicals by compatibility.
G. Label chemical storage areas as to their contents
H. Keep storage of chemicals at the lab bench or other work areas to a minimum.
I. Assume that any chemical mixture is as toxic as its most toxic component.
J. Assume substances of unknown hazard are toxic, and handle them as such.

5.6.1 Transporting Chemicals

When transporting chemicals outside the laboratory, precautions must be taken to avoid dropping or spilling chemicals. EH&S has developed the Hazardous Materials Transport Policy which provides additional detail on proper transport methods (see Appendix H). Never hand-carry an unprotected chemical outside of a laboratory.

5.7 Unattended Operations

At times, it may be necessary to leave a laboratory operation unattended. Operations and experiments that continue unattended for several hours or overnight must be pre-approved by the PI or laboratory supervisor. Plans must be made to eliminate the risk of hazards in the event of a failure in power, water, gas or other service. Water cannot be left running. **Do not cover or black out lab door windows**. Room lights must be left on and a notice must be placed on the lab door with the name and number of the researcher conducting the experiment and any pertinent information about the process.

Follow these basic guidelines in the design of an experiment to be left unattended:

A. Always check with your laboratory supervisor to determine if it is necessary to leave a laboratory operation unattended. If necessary, develop a protocol with your laboratory supervisor for the unattended operation of potentially dangerous equipment or methods. Develop a protocol for potential interruptions in electric, water, inert gas and other services and provide containment for toxic substances as part of the protocol.
B. A warning notice must be posted in the vicinity of the experiment if hazardous conditions are present.

5.8 Shared and Common Use Labs

The responsibility for housekeeping and the minimization of physical hazards and injuries in any shared lab or support space is the duty of all staff using the lab. It is imperative that all users clean up after themselves.

Photography dark rooms are to be treated as any other laboratory support space. A chemical inventory and the Chemical Hygiene Plan SOPs are required. PPE must be worn when handling chemicals. EH&S must be informed of dark room locations so that chemical disposal requirements may be addressed.

5.9 Space Utilization

While reassignment of laboratory spaces to different PIs is the purview of research departments, EH&S must be made aware these changes. Lab spaces must be evaluated and decommissioned by EH&S prior to reassignment to ensure continuity of chemical inventory, and to evaluate any legacy hazards in the space. Conversion of non-lab spaces into lab or chemical storage areas is subject to approval by EH&S. In most cases, conversion of non-lab spaces will require modifications to ventilation systems, and the addition of fire safety features.

5.10 Working Alone

Hazardous experiments **must not** be performed alone in a laboratory. When necessary, persons working alone shall make arrangements with other persons in the building or with Campus Police to check on them periodically.

5.11 Laboratory Security

Laboratories must be locked if no one is in the lab. Lab doors must be closed at all times. Acute toxins, select agents, controlled substances and radioisotopes must be appropriately secured. Do not hesitate to politely question anyone who does not belong in the area. It is recommended that lab staff politely decline to answer questions about the lab, chemical and biological inventories, the nature of the research or the building posed to them by the general public or press. If there is any concern about lab security, inappropriate questions or suspicious individuals, please contact NAU PD or the local responding agency immediately.

5.12 Visitors

Visitors to all laboratories must (unless an EH&S audit is taking place):

1. Be escorted by lab staff.
2. Be made aware of any potential hazards they may encounter in the lab.
3. Wear the correct personal protective equipment for the hazards present in the lab; no matter if they are visitors or maintenance workers or how long they will be in the lab.

4. Abide by laboratory regulations for access and control of hazards.
5. Pets are not allowed in labs. Only certified service animals may be allowed into NAU buildings.

5.13 Minors in the Laboratory

NAU has developed a Minors in Research Policy. This policy, and additional required forms pertaining to minors are located on the EH&S website. Minors under the age of 18 are not permitted to work in the laboratory unless they are a registered student or participating in a supervised program and the lab meets the following criteria:

- The project has been submitted, reviewed, and approved by EH&S
- Parental permission is granted to participate.
- Hours of participation may be limited by project, school attendance, etc. Please coordinate participants work hours with program coordinator.
- The laboratory is in full compliance with all safety regulations and programs (NAU Chemical Hygiene Plan, Biosafety Program, Radiation Control Program, Institutional Animal Care and Use Committee (IACUC), Institutional Biosafety Committee (IBC), etc.).
- The laboratory provides prerequisite safety and hazard awareness training to all staff including CHP and SOPs.
- The scholars program participant works under the direct supervision of the PI or senior lab staff whenever they are performing laboratory or scientific procedures.
- The minor may not be left alone in the lab.

Minors **may not** use or handle:

- Gas cylinders
- Explosives
- Select agents
- Highly toxic substances
- DEA controlled substances
- Level 3 or higher biological agents
- Radioactive materials
- Lab animals

Minors **may** use or handle the following only under the following conditions:

- Non-concentrated corrosives: Requires compound specific training by host lab PI
- Biosafety Level 2 materials: Approval of NAU BSO and the NAU IBC
- Recombinant DNA: Approval of NAU BSO and the NAU IBC

Minors **may not** operate farm equipment, high voltage equipment, equipment capable of amputation or state vehicles.

5.14 Storage and Disposal of Hazardous Waste

Disposal of all chemical, biological and radioactive waste generated by the Northern Arizona University is managed by EH&S. The Hazardous Waste Management Rules (Appendix G) provides guidance in this area. As NAU is subject to regulatory inspection and potential fines for non-compliance, it is of utmost importance that labs abide by the policies set by EH&S. Minimization of chemical wastes must be an integral part of the laboratory setup and operating procedures (for more information, contact EH&S for NAU's Waste Minimization Plan).

Chemicals must not be disposed of down drains, in ordinary trash receptacles, or by evaporation. Chemical wastes must be held at the generating location in a defined "satellite accumulation areas" until ready for pick up. A designated lab waste manager from each lab is required to attend training provided by EH&S.

Laboratories generating chemical wastes must familiarize themselves with the regulatory requirements and NAU policies.

The following is a summary of the chemical waste accumulation and disposal process at NAU.

5.14.1 Identification and Labeling

a. The chemical waste accumulation area must be identified with a "Waste Satellite Accumulation Area Requirements" posting.
b. The label must list all constituents and the percentages of each, totaling 100%. Waste logs may be used to list this information if they are kept in close proximity to the satellite accumulation area
c. Hazardous waste labels are available free of charge by calling EH&S.
d. Waste container labels must contain the words "Hazardous Waste", as well as generic hazard communication(s) (e.g. toxic, corrosive, flammable, reactive).

5.14.2 Waste Containers

a. All chemical wastes shall be accumulated in sealable containers.
b. Containers shall be kept closed during accumulation, except when adding waste to a container.
c. A funnel cannot be left in the container.
d. Do not over-fill containers; one inch of air space (from the top of the container) is required to allow for expansion.
e. Must be labeled "Hazardous Waste".

5.14.3 Accumulation

a. Do not accumulate more than 55 gallons of waste or 1 quart of a P-Listed waste per waste stream/per accumulation area.
b. Keep solids and liquids separate.
c. Segregate chemical wastes by class: acids, bases, halogenated, non-halogenated, oxidizers, and reactive chemicals.

5.14.4 Chemical Waste Pick Up

When a waste container is full, submit a service request on EH&S' website to arrange for pick-up. See page 6 for contact information.

For guidelines on the storage and disposal of hazardous wastes from laboratory operations at NAU, please contact EH&S Hazardous and consult the EH&S Hazardous Waste Management Rules (Appendix G).

5.14.5 Sharps

Sharps (needles, broken glass, scalpels, razor blades, etc.) must not be disposed of in the regular waste stream. Needles, syringes and scalpels must be placed in red plastic "sharps" boxes and disposed of as biomedical waste, no matter if they are contaminated with a biological substance or not. Used needles cannot be recapped, broken, bent or sheared. Non-contaminated broken glass must be placed in a rigid puncture resistant container. Uncapped needles must not be left where someone may sustain a needle stick. If the needle and syringe are to be used again, it must be placed in a wide mouth jar, beaker or otherwise secured so that staff using the area are protected from a needle stick injury.

New needles (and syringes) must be stored in a secure cabinet.

Razor blades, microtome blades and other objects that may puncture trash bags or boxes, regardless of contamination, must be disposed of into sharps boxes. Glassware disposal will vary depending on the building where it is generated. Biologically contaminated sharps must be properly inactivated before disposal. See

the NAU Biological Safety Manual for more information on disposal of all biologically contaminated waste.

6.0 SUBSTANCE SPECIFIC REQUIREMENTS

Regulatory requirements for storage, handling and disposal of hazardous substances vary based on substance-specific properties. The following subsections address those specifications.

6.1 Flammable/Combustible Material

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

	Flash Point	Boiling Point	Max. Allowable Qty. outside of flammable cabinet
Flammable			
Class IA	< 73 °F (22.8 °C)	< 100 °F (37.8 °C)	1 pint
Class IB	< 73 °F (22.8 °C)	≥ 100 °F (37.8 °C)	1 quart
Class IC	≥ 73 °F (22.8 °C) & < 100 °F (37.8°C)		1gallon
Combustible			
Class II	≥ 100 °F (37.8 °C) & < 140 °F (60 °C)		1 gallon
Class IIA	≥ 140 °F (60 °C) & < 200 °F (93 °C)		
Class IIIB	≥ 200 °F (93 °C)		1gallon

These classes give a measure of the fire risk. Appendix I lists some common flammable and combustible chemicals.

Note: the flash point is defined as the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. For handling Flammable/Combustible materials, observe the following guidelines:

A. Eliminate ignition sources such as open flames, hot surfaces, sparks from welding or cutting, operation of electrical equipment, and static electricity.
B. Store in NFPA approved flammable liquid containers or storage cabinets, in an area isolated from ignition sources or in a special storage room designed for flammable materials.
C. Ensure there is proper bonding and grounding when it is required, such as when transferring or dispensing a flammable liquid from a large container or drum. Assure bonding and grounding is checked periodically.
D. Assure appropriate fire extinguishers and/or sprinkler systems are in the area.

6.2 Compressed Gases

Special systems are needed for handling materials under pressure. Cylinders pose mechanical, physical and/or health hazards, depending on the compressed gas in the cylinder.

A. Cylinders must be labeled as to their contents and dated with a receipt date.
B. **Cylinders must be individually secured.**
C. When storing or moving a cylinder, have the valve protection cap securely in place to protect the stem.
D. Cylinders must be secured in an upright position at all times. Use suitable racks, straps, chains, or stands to support cylinders against an immovable object, such as a bench or a wall, during use and storage. Do not allow cylinders to fall or lean against one another.
E. Use an appropriate cart to move cylinders.
F. Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.
G. Oil or grease on the high-pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder. **Use an oxygen approved regulator**.
H. Always wear goggles or safety glasses with side shields when handling compressed gases.
I. Always use appropriate gauges, fittings, and materials compatible with the particular gas being handled.
J. When working with a toxic, corrosive, or reactive gas is planned, EH&S must be contacted for information concerning specific handling requirements. Generally, these gases will need to be used and stored with local exhaust ventilation such as a lab hood or a gas cabinet designed for that purpose.
K. When a cylinder is empty, label as such and contact the vendor for pick-up.

6.3 Corrosives

Corrosives are materials which can react with the skin causing burns similar to thermal burns, and/or which can react with metal causing deterioration of the metal surface (see Appendix J for a partial listing of corrosive substances). Observe the following guidelines when handling/working with corrosive materials:

A. Containers and equipment used for storage and processing of corrosive materials must be corrosion resistant.
B. Eye protection and chemically compatible gloves must always be used when handling corrosive materials. A face shield, rubber apron, and rubber boots may also be appropriate, depending on the work performed.
C. Never add water to acid. When mixing concentrated acids with water, add the acid **slowly** to water.
D. An eyewash and safety shower must be readily accessible to areas where corrosives are used and stored. In the event of skin or eye contact with

corrosives, immediately flush the area of contact with cool water for 15 minutes. Remove all affected clothing. Obtain medical help. See section 8.0 for eyewash and safety shower specifications.

6.4 Oxidizers

Oxidizers react with other substances by giving off electrons and undergo reduction. This reaction may result in fire or explosion. The intensity of the reaction depends on the oxidizing-reducing potential of the materials involved. See Appendix K for a partial listing of oxidizers. Adhere to the following guidelines when working with oxidizers:

1. Know the reactivity of the materials involved in the experiment or process. Ensure there are no extraneous materials in the area that will cause a reaction.
2. If the reaction is anticipated to be violent or explosive, use shields or other methods for isolating the materials or the process.
3. Perform this experiment in a fume hood for extra shielding.

6.5 Water Reactive Materials

Water reactive materials react with water to produce a flammable or toxic gas or other hazardous condition, often resulting in a fire or explosion. Safe handling of water reactive materials will depend on the specific material and the conditions of use and storage. Examples of water reactive chemicals include alkali metals such as lithium, sodium, and potassium; acid anhydrides, and acid chlorides. Perform work with water reactive materials in a fume hood for extra shielding.

6.6 Pyrophoric Materials

Pyrophoric materials ignite spontaneously upon contact with air. Often the flame is invisible. Examples of pyrophoric materials are silane, silicon tetrachloride, and white or yellow phosphorous. **Pyrophoric chemicals must be used and stored in inert environments.**

6.7 Peroxidizable Chemicals (Organic Peroxides)

Peroxidizable materials undergo auto-oxidation (a reaction with oxygen in the air) to form peroxides, which can explode with impact, heat, or friction. Since these chemicals may be packaged in an air atmosphere, peroxides can form even though the container has not been opened, necessitating careful handling. See Appendix F for a list of peroxidizable materials.

A. Date all peroxide formers upon receipt and upon opening. Dispose of or check for peroxide formation after the recommended time; 3-months or one

year depending on the chemical. See Appendix F for guidelines on dating and storage.
B. Do not open any container that has obvious solid formation around the lid or in the bottom.
C. Addition of an inhibitor to quench the formation of peroxides is recommended.
D. It is recommended to chemically test for peroxides periodically.
E. Follow the same basic handling procedures as for flammable materials.
F. Any peroxidizable chemical past its expiration will be collected for disposal, depending on the circumstances. Discretion lies with the EHS member who found the material.

6.8 Light-Sensitive Materials

Light-sensitive materials degrade in the presence of light, forming new compounds that can be hazardous, or result in hazardous conditions such as pressure build up. Examples of light sensitive materials include chloroform, tetrahydrofuran, ketones and anhydrides. **Store light-sensitive materials in a cool, dark place in amber colored bottles or other containers that reduce or eliminate penetration of light.**

6.9 Unstable Materials

Unstable materials can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated. Some chemicals become increasingly shock-sensitive with age. Of great concern in the laboratory is the inadvertent formation of explosive or shock-sensitive materials such as peroxides, perchlorates (from perchloric acid), picric acid and azides. A list of shock sensitive and explosive materials is provided in Appendix L.

A. Contact EH&S for suspected inadvertent formation of shock-sensitive materials in ductwork, piping, or chemicals being stored.
B. Date all containers of explosive or shock-sensitive materials upon receipt and again when opened.
C. If there is a chance of explosion, use barriers or other methods for isolating the materials or the process.

6.10 Cryogens

Cryogens include liquefied gases that condense oxygen from the air, create an oxygen rich atmosphere and increase potential for fire if flammable or combustible materials and a source of ignition are present. Pressure is also a hazard due to the large expansion ratio from liquid to gas, causing pressure build up in containers. Many materials become brittle at extremely low temperatures. Brief contact with materials at extremely low temperatures can cause burns similar to thermal burns.

Some of the hazards associated with cryogenic liquids are fire, pressure, weakening of materials, and skin or eye burns upon contact with the liquid.

A. Equipment must be kept clean, especially when working with liquid or gaseous oxygen.
B. Mixtures of gases or fluids must be strictly controlled to prevent formation of flammable or explosive mixtures.
C. Always wear safety glasses with side shields or goggles when handling cryogens. If there is a chance of a splash or spray, a full-face protection shield, an impervious apron or coat, cuff less trousers, and high-topped shoes must be worn. Watches, rings, and other jewelry must not be worn. Gloves must be impervious and sufficiently large to be readily thrown off in the event of a spill. Potholders can also be used.
D. Containers and systems containing cryogens must have pressure relief mechanisms.
E. Containers and systems must be capable of withstanding extreme cold without becoming brittle.
F. Since glass ampoules can explode when removed from cryogenic storage if not sealed properly, storage of radioactive, toxic or infectious agents must be placed in **plastic** cryogenic storage ampoules. Reheat cold sample containers slowly.

6.11 Substances that Require Special Handling

Many chemicals require special handling due to their properties and potential health hazards. The following subsections provide information on chemicals commonly used in laboratories. For more detailed information on these and other chemicals contact EH&S or visit EH&S' website: http://nau.edu/research/compliance/environmental-health-and-safety.

6.11.1 Nitric Acid

Nitric Acid is commonly found in NAU laboratories. Due to its chemical properties and health hazards, it requires special handling and precautions. When nitric acid is exposed to air, or comes in contact with organic matter it decomposes to yield toxic oxides of nitrogen, which leads to lung irritation, or pneumonitis and pulmonary edema which can be fatal. The onset of symptoms may be delayed. Eye contact with nitric acid will result in severe burns creating permanent vision impairment. It is a strong oxidizer and reacts explosively with combustible organic or readily oxidizable materials such as wood and metal powders. Never use paper towel or other oxidizable materials to absorb a nitric acid spill. It will attack some forms of plastic, and certain coatings, so consideration of container material is important. Nitric acid must be used in a fume hood, and the user must wear splash goggles and compatible gloves.

EH&S has developed an SOP for working with acids in laboratories. This SOP is available on the EH&S website and must be incorporated into the Site-Specific CHP for any lab using nitric and other acids.

6.11.2 Perchloric Acid

Perchloric acid is a strong acid used for complete digestions of organic material. It is normally supplied in bottles of up to one gallon in capacity at 70-72% strength. In many respects, its hazards are similar to those of nitric acid, as both are strong oxidants. **Perchloric acid presents an additional hazard in that perchloric acid mist and vapor can condense in ventilation systems to form explosive metallic perchlorates.** EH&S has developed an SOP for working with perchloric acid in laboratories. This SOP is available on the EH&S website and must be incorporated into the LCHP for any lab using perchloric and other acids.

Researchers using or anticipating the use of perchloric acid in their experiments must keep the following in mind:

1. Perchloric acid digestions of any size must be performed only in a perchloric fume hood. No open bench top digestions must be performed.
2. Any hood used for perchloric acid digestions must be properly constructed (glass-lined, etc.) for use with perchloric acid. **A standard fume hood is not acceptable for perchloric acid use.**
3. Perchloric acid digestions require a special perchloric acid hood with a wash-down system, or if infrequent use of small quantities, a hood fitted with a vapor trap apparatus similar to a micro Kjeldahl.
4. **Regardless of the size of the digestion, no organic solvents must be in the hood during the digestion**. Solvents must never be stored or used in a designated perchloric acid hood at any time. These hoods must be posted with a label stating **"Perchloric Acid Use Only. Organic Chemical Prohibited"**.
5. When diluting perchloric acid (or any other acid) always **ADD ACID TO WATER**, not the reverse.
6. Perchloric acid will attack researcher's tissues as easily as it will attack sample tissue. To prevent injury, goggles or face shield, chemically compatible gloves, and apron must be worn when handling perchloric acid.
7. Because of the potential for explosion, no work can be done on a hood used for perchloric acid digestions until it has been thoroughly decontaminated. Perchloric acid waste must not be mixed with any other waste. It must be put into acid-resistant bottles (preferably the original acid container), clearly labeled, and treated as hazardous chemical waste.
8. Perchloric acid must be segregated from all other chemicals **and** inside secondary containment (such as a pyrex baking dish or plastic dish pan). It must not be stored near organic acids such as acetic acid, near bases, or near other organic or flammable material.

6.11.3 Hydrofluoric Acid

Hydrofluoric acid has a number of physical, chemical and toxicological properties that make it especially hazardous to handle. Prevention of exposure or injury is the primary goal when working with HF. Any HF user must be intimately familiar with appropriate first aid in case of an exposure. When exposed to air, HF produces pungent, dangerous vapors. HF etches glass, and will react with glazed enamels, pottery, concrete, rubber and many organic compounds. Upon skin exposure, the fluoride ions of HF will readily penetrate the skin causing destruction of deep tissue layers. Skin contact with strong concentrations of HF will result in immediate, severe, burning and pain, which may continue for days. Skin contact with more dilute concentrations of HF may be less obvious to the user, and symptoms of exposure may be delayed for 8 hours or more. The fluoride ions in HF have an affinity for calcium ions found in the body and exposure can lead to low calcium levels and sudden death. Concentrated HF burns can be fatal even if only 2% of the body surface area is exposed.

Calcium Gluconate gel must be kept in any laboratory working with HF. This gel can be applied in the event of skin exposure to bind the fluoride ions of HF. Calcium gluconate gel must be stored properly and replaced annually.

EH&S has developed an SOP and a training for working with HF in laboratories. This SOP contains first aid requirements and guidance. It is available on the EH&S website and must be incorporated into the Site-Specific CHP for any lab using HF. EH&S' HF training is highly recommended.

6.11.4 Ethidium Bromide

Ethidium bromide is also commonly found on the NAU campus. Due the mutagenic and toxic properties of ethidium bromide, it must only be used in a fume hood and chemical splash goggles and users must wear compatible PPE.

EH&S has developed an SOP for working with Ethidium Bromide in laboratories. This SOP contains additional precaution and handling information as well as waste disposal guidance. This SOP is available on the EH&S website and must be incorporated into the Site-Specific CHP for any lab using Ethidium Bromide.

6.12 Hazards Subject to Review or Prior Approval

The Laboratory Standard requires that PIs identify those activities believed to be of a sufficiently hazardous nature to warrant prior approval before implementation by an employee.

6.13 Provisions for Particularly Hazardous Substances

A **particularly hazardous substance** is characterized as any compound that meets the criteria of select carcinogen, mutagen, reproductive toxin, or is acutely toxic. This also includes chemicals whose toxic properties are unknown. The Lab Standard requires that special precautions for additional employee protection be followed for the laboratory use of particularly hazardous substances.

To minimize exposure, it is necessary to determine the route by which exposure may occur, whether by inhalation, absorption, injection, ingestion or a combination of exposure routes. To ensure employees do not receive exposures in excess of applicable limits, hygienic standards have been established for many toxic materials. The following general hygiene practices must be observed when using select carcinogens, reproductive toxicants and chemicals with a high degree of acute and chronic toxicity.

Establish a designated area.

1. Designated and signed area must be a low-traffic location.
2. Use and store materials only in designated areas: a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances. Assure that all personnel with access are aware of necessary safety precautions.
3. Label all containers, storage and use areas appropriately. Follow the guidelines established in section 3.7.3 of this document.

Use proper containment devices for the protocol and chemical(s) being used.

1. Use a fume hood or other containment device for procedures which may result in the generation of aerosols or vapors; trap released vapors to prevent their discharge with fume hood exhaust.
2. It is recommended that breakable containers be stored in chemical-resistant trays. Work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper.

Contaminated Waste Removal

Follow the NAU Hazardous Waste Management Rules outlined in Appendix G of this document.

Follow decontamination procedures prior to leaving the designated area.

1 On leaving the designated area, remove protective apparel (place it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck.
2 Thoroughly decontaminate or dispose of contaminated clothing or shoes. If possible, chemically decontaminate by chemical conversion to a less toxic product.

3 Decontaminate vacuum pumps or other contaminated equipment, including glassware, before removing them from the designated area. Decontaminate the designated area before normal work is resumed.
4 Use a wet mop or a vacuum cleaner equipped with a HEPA filter to decontaminate surfaces. DO NOT DRY SWEEP SPILLED POWDERS.
5 Protect vacuum pumps against contamination with scrubbers or HEPA filters and vent effluent into the hood.

Always take extra precautions when working with particularly hazardous chemicals.

1. Consult the SDS for toxic properties and follow the specific precautions and procedures.
2. Guard against spills and splashes. Appropriate safety apparel, including chemically compatible gloves, must be worn. All hoods, glove boxes, or other essential engineering controls must be operating properly before work is started.
3. Notify the PI of all incidents of exposure or spills.

Hazardous chemicals require that employees follow special procedures for handling and storage. The PI or laboratory supervisor must create specific SOP's for unit safety.

6.14 Chemicals Developed in the Laboratory

The following requirements apply to chemical substances developed in the laboratory:

1. PI's must determine if laboratory chemical compositions are hazardous. This can be done by a literature search for similar substances. If the chemical is determined to be hazardous, the PI must provide appropriate training to protect employees.

2. If the chemical produced is a product or a by-product whose composition is not known, the PI must assume that the substance is hazardous and must comply with the requirements of the CHP, including labeling requirements.

3. If the chemical is produced for sale or use outside of the laboratory, the PI must prepare an appropriate SDS in accordance to the Federal Hazard Communication Standard (29 CFR 1910.1200).

6.15 Radioactive Material Hazards

Use of radioactive materials at NAU is strictly controlled. Contact EH&S' EH&S Radiation Safety Officer (RSO) if you plan to use radioactive materials.

6.16 Biological Material Hazards

Research, academic, and clinical Principal Investigator's involved with the use of recombinant or synthetic nucleic acid molecules or hazardous biological materials, including unfixed human derived materials, must apply for approval from NAU's Institutional Biosafety Committee (IBC) prior to beginning any work with these materials. The IBC at NAU is a faculty-led committee of experts in biosafety-related fields responsible for reviewing and approving research, teaching, and clinical activities utilizing recombinant or synthetic nucleic acid molecules, infectious agents, biologically derived toxins, or other potentially hazardous biological agents. The guiding principle of the IBC is to assist faculty, staff, and students using potentially hazardous biological agents in performing those activities in ways that eliminate or reduce potential exposure to personnel, students, animals, and the environment. The IBC carries out these functions pursuant to requirements set forth by federal, state, and local agencies, as well as NAU policies, including:

- National Institutes of Health Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines);
- Occupational Safety and Health Administration's Bloodborne Pathogens Standard;
- Centers for Disease Control and Prevention and National Institutes of Health's Biosafety in Microbiological and Biomedical Laboratories (BMBL) 5th Edition;
- United States Government Policy for Institutional Oversight of Life Sciences Dual use Research of Concern (identified by the IBC and referred to the Institutional Review Entity);
- Centers for Disease Control and Prevention /United States Department of Agriculture Select Agent Program.

For assistance or additional information please contact biosafety@nau.edu.

7.0 EMERGENCY/MEDICAL PROCEDURES

With proper pre-planning, the potential for employee injury and property damage can be reduced The NAU Office of Emergency Management has established Emergency Procedures that must be printed (preferably on red paper for uniformity) and posted in all laboratories. The following subsections provide further guidance for characterizing and incident and proper response. First and foremost, any user must be familiar with the SDS of the chemical(s) being used.

7.1 Medical Emergencies

PI's must report all chemical exposures and occupational injuries using the Online Report of Injury (see Section 6.6.1).

In all cases of a medical emergency, chemical exposure, or injury, it is advised that the injured employee seek immediate medical attention (NAU Campus Health or Flagstaff Medical Center Emergency Room). Injured employees must be escorted to a medical center.

7.2 First Aid

In the event of an incident involving a health emergency, injury or illness, take the following steps:

1. Remain calm.
2. Call 523-3000 (campus dispatch will notify the proper responders).
3. Visually survey the area to ensure that it is free of hazards.
4. Initiate lifesaving measures as needed.
5. Summon medical help.
6. Do not move any injured person unless absolutely necessary.

Provide on-site first aid treatment to stop bleeding, cool burns or in the event of chemical splash, by flushing with water at a safety shower or eyewash. Remove any jewelry in the affected area. If a delayed action of the chemical splash is possible (e.g. phenol, hydrofluoric acid, methyl and ethyl bromides) obtain medical attention promptly.

Note: Do not dispense or administer any medications, including aspirin. Do not put any ointments or creams on wounds or burns unless your laboratory has a specific protocol for doing so (e.g. calcium gluconate gel). Instead, use cool water.

7.2.1 Chemical Splashes

Attending to victims in the event of a chemical splash to the body:

1. Consult SDS
2. Remove person(s) from spill area to fresh air only if attempts to rescue victim(s) do not present a danger to the rescuers.
3. Remove contaminated clothing while under an emergency shower.
4. Flood affected area with cold water for at least 15 minutes or longer if pain persists.
5. Wash skin with mild soap and water - do not use neutralizing chemicals, ointments, creams, lotions or salves.
6. Contact emergency response personnel and assure they know the chemical(s) involved. Provide the SDS to emergency personnel whenever possible.
7.

Attending to victims in the event of an eye splash:

1. Consult SDS
2. Remove victim(s) from spill area to fresh air only if attempts to rescue victim(s) do not present a danger to the rescuers.
3. Lead the victim(s) immediately to an emergency eye wash facility.
4. Hold eye lids open.
5. Flush eyes for at least 15 minutes or longer if pain persists.
6. Contact emergency response personnel and assure they know the chemical(s) involved. Provide the SDS to emergency personnel whenever possible

Hydrofluoric acid burn – Consult SDS. The area must be rinsed immediately with running water for 2-5 minutes. A calcium gluconate compound must be applied to the area. Seek medical treatment immediately.

Phenol burns – Phenol has the ability to penetrate the skin and cause severe burns, and can anesthetize the area so little or no pain may be felt. In case of exposure, flush with water. Seek medical attention immediately. Substances such as polyethylene glycol may be used to neutralize and treat the burn in the hospital.

In the event of a **cryogen or dry ice burns (frostbite),** flood or soak with tepid water. **Do not use hot water**. Seek medical attention.

All contaminated clothing must be labeled and disposed of as hazardous waste.

7.2.2 Ingestion of a toxin

Call the CHEMTREC Emergency Call Center for guidance: 1-800-262-8200. Consult SDS. Dilute the poison by having the victim drink large amounts of water (do not give liquids to an unconscious or convulsing victim). Attempt to learn what the ingested substance was. Obtain medical treatment immediately. Save the label or container for transportation with the victim to the medical facility.

7.2.3 Inhalation of Chemical Fumes

Take the individual to fresh air, seek medical assistance immediately, and provide artificial respiration or CPR as needed. Consult SDS

7.3 Fire

In the event of a fire, dial 911 for NAU Campus Police.

If clothing is on fire, help the individual to the floor and roll him/her around to smother the flames. If a safety shower is immediately available, douse the person with water to cool the skin. Seek immediate medical attention.

In case of a fire emergency- remember the acronym R*A*C*E

R- Rescue- Without entering a hazardous situation or area, rescue and remove all individuals from the area.
A- Alarm- Activate alarms/alert occupants in the building
C- Confine- all doors, windows and access to the affected area must be closed to confine spread of the fire and smoke. All access must then be restricted to emergency response personnel only.
E- Evacuate - evacuate the area to allow the emergency response personnel to fight the fire.

OR

E- Extinguish - attempt to extinguish the fire only if all of the following criteria can be or have been met:

1. Training has been received on how to use a fire extinguisher.
2. The proper extinguisher is available.
3. The fire has not spread from its point of origin.
4. The fire is still small enough to be handled by the available fire extinguisher.
5. The fire can be fought with your back to the exit to ensure there is a means of escape in the event that the attempt to extinguish the fire fails.
6. Emergency response has been notified by calling 911, and building alarm have been activated.

7. If the fire is not extinguished after using one fire extinguisher, close all doors, activate the nearest fire alarm, and leave the building.

7.4 Chemical Spills

Laboratory staff members may clean up only small **incidental spills** that constitute a minimum hazard. Contact EH&S for coordination of large chemical spills clean up (see emergency contact information in the front of this manual). All lab staff must become aware of procedures to follow and precautions to take for the chemicals they are using as a part of their lab-specific training.

7.4.1 Incidental Chemical Spills

An incidental chemical spill is characterized as a spill or release that does not pose significant safety or health hazards to person(s) in the immediate vicinity and does not have the potential to become an emergency within a short time frame. The following situations are incidental and **ARE NOT** emergency situations:

1. The person causing or discovering the release understands the properties and can make an informed decision as to the exposure level.

2. Lab personnel can clean up the spill according to SDS.

3. The materials are limited in quantity (generally less than 1 liter), exposure potential, or toxicity and present minor safety or health hazards to persons in the immediate work area or those assigned to clean up the activity.

4. Incidental releases of hazardous substances that are routinely cleaned up by trained lab employees or EH&S need not be considered an emergency.

For an **incidental spill**, follow the following procedures:

1. Alert personnel in the immediate area.
2. Avoid breathing vapors and try to determine what has spilled.
3. Turn off ignition sources in the immediate area.
4. If someone has been splashed with chemical, immediately flush the affected area with copious amount of water for at least 15 minutes.
5. Wear protective equipment including safety goggles, chemical resistant disposable gloves, shoe covers, and a long-sleeve lab coat.
6. Use a commercial kit or the materials discussed in Section 3.8 to pick-up spilled materials. Confine the spill to a small area by surrounding the perimeter of the spill first, continuing towards the center.
7. Place the used absorbent in a plastic bag or bucket and label it with a Hazardous Waste label.
8. Clean area with water.
9. For acids or base spills: Neutralizing these spills may release hazardous fumes. If you are unsure of the resulting reaction, use an inert absorbent.
10. For alkali metals: smother the spill with a special Class D, dry powder extinguisher.
11. For mercury spills see the special procedures in Section 6.4.3.

When cleaning spills, keep in mind that some sorbents are chemically specific. The best sorbents can be used to clean up all types of chemical spills. Check absorbents in spill kits for their absorbency range.

Each laboratory's spill kit must be kept in a readily accessible, easily locatable and signed location and each employee must be trained on how to use the spill kit.

Follow the NAU Hazardous Waste Management Rules (Appendix G) when disposing of spill and absorbent materials.

7.4.2 Chemical Spill/Release

Releases of hazardous substances that pose a significant threat to health and safety or that, by their very nature, require an emergency response regardless of the circumstances surrounding the release or the mitigating factors are emergency situations. The following definitions designate an **emergency situation**:

1. The situation is unclear to the person causing or discovering the spill.
2. The release requires evacuation of persons.
3. The release involves or poses a threat of
    - Fire, suspected fire, explosion or other imminent danger
    - Conditions that are Immediately Dangerous to Life and Health (IDLH)
    - High levels of exposure to toxic substances.
    - The person(s) in the work area is uncertain they can handle the severity of the hazard with the personal protective equipment (PPE) and response equipment that has been provided and/or the exposure limit could easily be exceeded

In the event of a **large chemical spill** or release use the following procedures:

1. Avoid breathing vapors.
2. Quickly identify the spilled material if it can be done safety.
3. If the spill involves a flammable liquid, turn off all ignition sources, if it can be done safely.
4. Immediately evacuate the area, closing all doors.
5. If someone has been splashed with the chemical, immediately flush the affected area with copious amounts of water for at least 15 minutes (see Section 6.2)
6. Keep all personnel away from the spill area until EH&S/Emergency personnel arrive to evaluate and control the situation. Place a sign at all doors to the spill location advising personnel not to enter the room.
7. Personnel most knowledgeable about the spilled material must be available to provide information to EH&S/Emergency personnel.

Exposure Monitoring for employees or those in the surrounding area if there is reason to believe that the exposure level of any chemical may exceed 50% of the action level, the Ceiling level, or the Permissible Exposure Limit (PEL). Monitoring will be performed by EH&S staff or a designee approved by EH&S. Results of the monitoring will be discussed with the affected employee(s).

7.4.3 Mercury Spills

With proper planning, small mercury spills can be cleaned by laboratory staff. EH&S strongly recommends the replacement of older mercury containing devices either with those resistant to breakage or with mercury alternative devices where possible.

For very small mercury spills, less than 1 cc, such as a broken thermometer, use a trapped vacuum line attached to a tapered glass tube, similar to a medicine dropper, to pick up mercury droplets.

1. Do not use a domestic or commercial vacuum cleaner.

2. Cover small droplets in accessible areas with one of the following:

    - sodium polysulfide solution
    - powdered sulfur
    - silver metal compounds
    - dry ice to freeze the mercury droplets

3. Place residue in a sealed and labeled container for hazardous waste collection.

7.5 Power Outages

If emergency lighting and fire alarms **ARE NOT** operable, evacuate the building after the following steps have been taken:

- Place lids on all open containers of volatile chemicals
- Lower the sash on chemical fume hoods
- Shut down all equipment (leave cooling water and purge gases on as necessary)
- Turn off ignition sources
- Secure or isolate reactions that are underway (boiling liquid on a hot plate, distillations)
- Close fire doors
- Take your books, coats, purse/wallet, keys, etc.
- Lock outside door to lab

In anticipation of possible power outages, do the following:

- Have a flashlight conveniently located or other emergency lighting
- Make sure that all emergency contact numbers on the door are accurate and updated

7.6 Injury and Illness

NAU has established the following procedures for the reporting and investigation of injuries and illness.

7.6.1 Accident Reports

In the event of a laboratory accident that results in injury or illness, the laboratory supervisor must use the Report of Online Injury (ROI) tool.

The online ROI is available through Louie Department Self Service.

- Sign on to LOUIE
- Select **Department Self Service**
- Select **Report of Injury Home Page**
- Choose Create a **Report of Injury**
-

Learn more about the ROI process

- Instructions on Completing a ROI
- Frequently Asked Questions (FAQ)
- Process for Reporting a Work-Related Injury
- Industrial Leave Policy

You can also use the online ROI to report a non-employee injury or an employee injury that occurs outside of work hours. Learn more about the process to report a Third Party Report of Injury

7.6.2 Follow-up Investigations

EH&S will perform follow-up investigations for all exposures and injuries. Staff will be interviewed to ascertain the circumstances involved with the incident and measures will be recommended to prevent recurrence when appropriate.

8.0 LABORATORY EQUIPMENT

The types of equipment and instrumentation used in university lab settings are as diverse as the various research performed. Although each will have its own specific safety requirements, there are some general guidelines to follow whenever operating lab equipment and instrumentation:

1. Always keep the manufacturer's operating manual with the instrument.
2. Follow recommended maintenance procedures outlined in the manual.

3. New operators must be trained by qualified lab personnel and familiarize themselves with the operating manual, including all pertinent safety information.
4. Never remove hazard-warning labels from an instrument.
5. Ensure that all equipment is grounded.
6. Have a certified technician perform or oversee repairs.
7. Disconnect equipment from the power-source whenever conducting maintenance on the instrument (follow OSHA Lockout/Tagout procedures).
8. If the equipment is used near any source of water, ensure that it is plugged into an outlet equipped with a Ground Fault Circuit Interrupter (GFCI). Note: do not plug continuous running equipment such as freezers, into GFCI outlets. See Section 9.2.4 for more information on electrical safety.
9. If compressed gases are used with the instrument, follow the NAU Compressed Gas Rules (see Section 5.2).
10. Be aware of, and be trained in the unique hazards of your instrument. (i.e. lasers, UV light, radiation sources, etc.)
11. Use protective equipment recommended by the manufacturer when using the instrument. (i.e. hearing protection, face shield, etc.)

8.1 Refrigerators, Freezers, and Cold Rooms

Refrigeration systems, whether it is an appliance or building system, may not be modified or repaired by laboratory staff. Appropriate CAS personnel or a certified refrigeration mechanic must be contacted to work on these systems.

Refrigerators and freezers must be level to prevent samples and solutions from spilling when their doors are opened. Sharp edges or corners on equipment must be protected or equipment must be relocated to minimize injury. Microtome blades or other sharp objects must be removed from equipment or covered with a protective guard when not in use. Belt and pulley systems, such as on vacuum pumps, or any other pinch points must be covered by a protective guarding.

8.1.1 Equipment Labeling

All refrigerators, freezers and cold rooms must be labeled with an Emergency Call List to identify who must be called in case of equipment or power failure. This is especially important when the equipment is located in shared space, common rooms, alcoves, etc.

Every refrigerator, freezer and cold room must also be clearly labeled to indicate whether it is suitable for storage of flammables, biological or radiological materials. Household refrigerators and freezers must be labeled “Danger-Do not put flammable liquids in this refrigerator/freezer.” Units must also be labeled for contents e. g., ‘No Food,’ ‘Food Only’.

8.1.2 Flammable Storage

Household refrigerators and freezers are not equipped with explosion-safe controls and may not be used to store flammable liquids.
Only UL listed flammable storage refrigerators may be used.

The use and storage of flammable liquids in cold rooms must be minimized. These rooms are not fire rated and are similar to a confined space, as they are not vented with fresh air. Please contact EH&S for an evaluation of these rooms and their use.

8.2 Centrifuges

Each operator must be trained on proper operating procedures. The use of centrifuges requires that they be balanced to prevent damage to the unit, the area or cause an injury to the operator. Any centrifuge that makes noise or vibrates must be stopped immediately and checked for balancing of the rotor. A log must be kept detailing operation for centrifuges and rotors.

1. Label centrifuges used for biohazards or radioisotopes.
2. Check the rotor for rough spots, pitting, and discoloration. If discovered, check with the manufacturer before using. Use professional rotor inspection services as required or recommended by the manufacturer.
3. Ultra centrifuge rotors require a log of rotor use and inspection. Damaged rotors must be removed from service immediately.

8.3 Vacuum Systems

Vacuum systems must not be used for any reason other than to pull vacuum on equipment. Do not use in-house plumbed or secondary vacuum pumps to remove water, dust or other materials.

All vacuum systems must be used with a secondary containment trap. Cold traps must be in place when flammable vapors are extracted by vacuum. It is strongly recommended that flow restrictors be used in line to minimize solvent loss.

A hydrophobic in-line filter must be placed between the last collection vessel and the vacuum port in systems used for aspirating liquids. This is recommended for both plumbed vacuum lines and for portable vacuum pumps. This filter will stop debris and liquid from entering the system and help to prevent contamination or degradation of the vacuum system.

8.4 Heating Equipment

Steam-heated devices shall be used rather than electrically heated devices or Bunsen Burners whenever possible. Steam-heated devices do not present shock or spark hazards and can be used with assurance that their temperature will not rise beyond 100°C.

8.4.1 Electrical Heating Devices

Only hot plates with heating elements enclosed in a glass, ceramic, or insulated case must be used in laboratories. All electrical equipment must be UL approved.

Heating mantles must be checked before each use for broken insulation and to assure that no water or other chemicals have been spilled into the mantle. Laboratory workers must be careful not to turn a variable transformer so high as to exceed the input voltage recommended for the mantle by the manufacturer.

Oil baths must always be monitored with a thermometer or other device to ensure that their temperature does not exceed the flash point of the oil being used. Smoke caused by the high temperature decomposition of the oil or of organic materials in the oil represents an inhalation hazard. Laboratory workers using an oil bath must guard against the possibility that water or another volatile substance could fall into the hot bath. Such an accident can splatter hot oil over a wide area. The oil bath must be supported on a solid surface.

8.4.2 Gas Burners

Where burners are used, distribute the heat with a wire gauze pad. Tubing for the gas must be checked to ensure it is properly attached with clamps and is not cracked. Burners must not be used in fume hoods or biological safety cabinets, as the continual high-volume airflow through these units may extinguish the flame and go unnoticed. Also, flames in a biological safety cabinet can disrupt the airflow and compromise the protective capability of the cabinet. Burners must not be left on when not in use or when the user leaves the immediate area.

8.5 Cooling Equipment

Running tap water must not be used for cooling of any experiment or equipment for longer than 30 minutes, as per the NAU CAS Utilities Policy. If cooling water is needed for longer periods, a self-contained cooling system must be used.

Special care must be taken if dry ice or a cryogenic liquid, such as liquid nitrogen or helium is used in a cooling system. Follow the guidelines in Section 5.10 for using these substances.

8.6 Glassware

Careful handling and storage procedures must be used to avoid damaging glassware. All glassware must be inspected prior to use. Damaged items must be discarded or repaired. Wear safety glasses and puncture resistant gloves when washing glassware.

Consideration must be given to the health hazards of a particular glass cleaner being used. Due to the health hazards associated with aggressive cleaners such as Chromerge, Aqua Regia and acidic peroxide solutions, their use is **strongly discouraged.** EH&S recommends the use of Alconox as an alternative to these products wherever possible.

8.7 Hoses

Prior to use, all tubing and connections must be inspected. Replace cracked or split tubing before use. Ensure that all connections are secured, and use hose clamps as required.
Hand protection must be utilized when inserting glass tubing into stoppers or when placing rubber tubing on glass hose connections. Tubing must be fire polished or filed smooth and lubricated. A cloth must be wrapped around the glass. Hands must be held close together and the glass inserted with a slight twisting motion, avoiding excessive pressure.

8.8 Disposal of Used Equipment

All laboratory equipment used in conjunction with chemical, biological or radioactive substances must be certified that it is safe for disposal or storage prior to its removal from the lab. The Equipment Release for Maintenance/Repair, Relocation, and/or Public Sale Policy outlines procedures to meet these requirements and is included in Appendix M. The department or lab will be responsible for the decontamination and/or disinfection of the equipment, draining all liquids and oils, and certifying that these procedures have been done properly. An Equipment Release Form must be filled out following decontamination and prior to submitting a request to CAS for removal/disposal (see Appendix M).

- Lab stuff must decontaminate all equipment prior to disposal process.
- Refrigerants (Freon) must be removed from any equipment prior to disposal. This may include refrigerators, freezers, centrifuges, etc.
- A certified technician must decontaminate Biological Safety Cabinets prior to disposal (call EH&S for current contractor information). If the equipment has been used with radiological substances, clean and decontaminate the apparatus and then call EH&S RSO to have the equipment surveyed.
- If there are concerns that the equipment contains asbestos (such as with older ovens), contact NAU CAS to have the item sampled prior to disposal.

9.0 SAFETY EQUIPMENT

All safety related equipment and information must be clearly labeled and stored in an area where it can be easily found in an emergency.

9.1 First Aid Kits

A first aid kit must be located in a clearly visible place in each laboratory. First aid kits are available for ordering through any laboratory or safety equipment supplier. Additional first aid items may be required depending on the chemicals used in the lab. Consult your laboratory's Safety Data Sheets (SDS) collection for specific first aid requirements.

9.2 Spill Kits

NAU requires all labs to maintain spill control materials in the event of a chemical spill. Commercial spill kits including instructions, absorbents, neutralizers, and protective equipment can be purchased through a commercial laboratory supply company. A large centrally located spill kit may be used for a suite of labs, provided it is placed near the area(s) with the highest potential for spills and is always available to staff.

Chemical spills can be handled safely and effectively if preplanning has been conducted. Individuals must be trained in proper cleanup procedures before a spill occurs. This preplanning must include consideration of:

1. Likely location(s) of a spill
2. Estimated quantities that may be released
3. Chemical and physical properties of the material (e.g. physical state, vapor pressure, and air or water reactivity)
4. Potential health hazards of the spilled material
5. Personal protective equipment that will be needed
6. Type of spill absorbents that will be required (see below)

A chemical spill kit can be assembled and stored in a high-density polyethylene bucket. The bucket can be used for collection of the chemical and absorbent in the event of a spill. Label the spill kit clearly. The following list of items to include in the spill kit is offered as a general guideline:

1. Neutralizing agents such as sodium carbonate, sodium bicarbonate or sodium bisulfate for corrosive spills.
2. Inert clay absorbents such as vermiculite or cat litter can be used for most types of chemicals.
3. Inert absorbent pads and pillows (can be purchased from Fisher Scientific https://www.fishersci.com/wps/portal/HOME?LBCID=21516330).
4. Polypropylene absorbents must be used for hydrofluoric acid (HF) spills (expanded silicate absorbents may react with hydrofluoric acid). Polypropylene absorbents can be used for most other chemical spills as well. These can be purchased from a commercial laboratory supply company. Calcium gluconate is required in each lab using HF (see Section 5.11.3).

5. A mercury spill kit (or vacuum line, flask, needle-nose pipette, and trap) for mercury spills and broken mercury thermometers.
6. Personal Protective Equipment (gloves, goggles, aprons, etc.) to wear during the cleanup.
7. Hazardous Waste labels, bags and a small scoop or shovel (for clay absorbents).

Note: Paper towels, rags or sponges are not recommended as some chemicals (strong oxidizers such as nitric acid) may ignite upon contact. Also, they are inadequate for large spills, as they do not absorb and reduce vapors as well as clay or commercial absorbents. For more information concerning chemical spill kit requirements for your lab, consult the Safety Data Sheets (SDS) for the chemicals on the lab's inventory.

9.3 Fire Extinguishers and Fire Alarms

Appropriate fire extinguishers shall be supplied by NAU Fire Life Safety Group and shall comply with National Fire Protection Association (NFPA). Stored items or equipment must not block access to fire extinguishers. Please address any questions concerning fire extinguisher types, locations or training to Fire Life Safety at 523-2350 or through their website: Fire Life Safety.

If a fire alarm sounds in the lab, consider it a fire situation and act accordingly. Shut down any processes and close all fume hood sashes. Leave the building and report to the designated meeting point for a head count. Call 523-3000 to report the emergency.

9.4 Engineering Controls and Work Practices

An employer must provide protection from health hazards in the lab by using engineering controls. Engineering controls are barriers or equipment used to isolate or remove a hazard from the workplace. Fume hoods, biological safety cabinets, glove boxes, local exhaust and shielding are some of the more commonly used engineering controls in a lab setting. It is the responsibility of the Principal Investigator to determine the need and type of engineering controls required for the lab. EH&S staff is available for assistance.

Safe work practices specific to the task being performed, combined with the general practices outlined in this manual, are the lab worker's next line of defense against health hazards. Lastly, when engineering controls and work practices cannot totally eliminate hazards, personal protective equipment (PPE) must be employed.

9.5 Personal Protective Equipment (PPE)

Personal protective equipment (PPE) includes (but is not limited to): gloves, aprons, lab coats, respirators, safety glasses, chemical splash goggles and face-shields.

The OSHA PPE Standard (29 CFR 1910.132) requires that employers assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). If such hazards are present, or likely to be present, the employer must select, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment. At NAU, this responsibility resides with the PI or her/his designee. This responsibility involves the following:

1. Workplace hazard assessment
2. Hazard identification
3. Appropriate PPE selection
4. Communication of the need and proper use of PPE to the employee
5. PPE fitting and training for the employee
6. Verification that the workplace hazard assessment has been performed through a written certification that identifies the workplace evaluated; the person certifying that the evaluation has been performed; the date(s) of the hazard assessment

The department or laboratory shall provide PPE to each staff member. It will be the responsibility of each staff member to use the PPE correctly and to keep it clean and in good repair.

EH&S has developed a PPE Hazard Assessment Form (Appendix N) for use by PIs to fulfill this legal requirement.

9.5.1 Gloves

Protective gloves shall be worn when working with hazardous materials or with materials of unknown toxicity. No glove will provide universal protection from all chemicals. The proper glove for the chemical being used will not protect the wearer indefinitely. Gloves must be selected on the basis of the material being handled and their suitability for the particular laboratory operation. In cases of latex sensitivity, alternative gloves must be provided.

A glove compatibility chart must be consulted to ensure the proper glove selection. Glove compatibility charts are available. Please be aware that glove compatibility charts are brand specific.

Gloves must not be worn outside of the lab. If a compound must be transported to another location, use a secondary container and wear one glove on the hand holding the container. Use the un-gloved hand to open doors, push elevator buttons, etc.

9.5.2 Eye and Face Protection

Eye protection shall be worn at all times when working with chemical, biological or radioactive substances. Safety glasses must have side shields and conform to ANSI Z 87.1. Ordinary prescription glasses will not provide adequate protection from injury to the eyes.

Safety goggles and face shields shall be utilized where there is a possibility of splashing chemicals, violent reactions or flying particles. Specific goggles shall be worn for protection against laser hazards, ultraviolet or other intense light sources.

General Description

Manufactures stamp all eye protective devices with "Z87" if they meet ANSI standards. If the eye protection is not marked, it may not be the most effective protection available.

1. Safety glasses with side shields offer minimal protection against flying fragments, chips, particles, sand and dirt. When a splash hazard exists, other protective eye equipment must be worn.

2. Safety goggles (impact goggles) offer adequate protection against flying particles. These must be worn when working with glassware under reduced or elevated pressure or with drill presses or other similar conditions.

3. Chemical splash goggles (acid goggles) have indirect venting for splash proof sides, which provide adequate protection against splashes. Chemical splash goggles offer the best eye protection from chemical splashes. Impact goggles must not be worn when danger of a splash exists.

4. Face shields protect the face and neck from flying particles and splashes. Always wear additional eye protection under face shields. Ultra-violet lightface shields must be worn when working over UV light sources.

Eye protection must be made available to all employees or visitors to laboratories where chemicals are used and stored. Protective eye and face equipment must be used where there is a reasonable probability of injury from hazardous chemicals that can be prevented from such equipment. The minimum acceptable requirements are for hardened glass or plastic safety spectacles. **The PI or laboratory supervisor must establish the level of eye protection needed per laboratory activity based on the guidelines below.**

Selecting Appropriate Eye and Face Protection in Laboratories

Safety Glasses: required when an impact hazard exists or when working with low hazard chemicals, or when a low probability of splash exists.

Examples:

- Pipetting
- Handling closed bottle of injurious chemical
- Mixing solutions
- Opening centrifuge tubes

Chemical Splash Goggles: required when working with smaller amounts of corrosive or injurious chemicals and a reasonable probability of splash exists.

Examples:

- Pouring acid out of a 1-pint bottle
- Pouring methylene chloride from a 1-liter bottle
- Working with liquids under pressure

Face Shield and Chemical Splash Goggles: required when working with larger quantities of corrosive chemicals and / or a high probability of eye and face injury exists.

Examples:

- Working with an acid bath
- Pouring 4 liters of acid into a container
- Handling highly reactive chemicals that may spatter

Note: Ordinary prescription glasses do not provide adequate protection against eye injury. Eye protection equipment must be ANSI Z87 approved.

9.5.3 Lab Coats

Laboratory coats or gowns must be worn over personal clothing and exposed skin when chemical, biological or radiological substances are being used. Lab coats must be buttoned or fastened closed and long enough to cover the wearer to below the knees. Lab coats must not be removed from the lab area and must not be taken home for laundering. Various departments on campus have arranged for

professional laundering through outside services. Contact NAU Purchasing for more information.

9.5.4 Protection of Skin and Body

Skin and body protection involves the use of protective clothing to protect individuals from chemical exposure. Determine clothing needed for the chemical being used, as protective garments are not equally effective for every hazardous chemical. Some chemicals will permeate a garment shortly, whereas others will not.

The basic and most effective forms of protection are gloves and lab coats.

Protect exposed skin surfaces when there is a reasonable anticipation of a splash. Avoid wearing open-toed shoes, sandals, shorts, etc. when working with injurious or corrosive chemicals.

Even when there is minimal danger of skin contact with an extremely hazardous substance, lab coats, coveralls, aprons, or protective suits must be utilized. **These garments must not leave the work site.**

Exposures to strong acids and acid gases, organic chemicals and strong oxidizing agents, carcinogens, and mutagens require the use of specialized protective equipment that prevents skin contamination. Impervious protective equipment must be utilized. Examples include: rubber gloves, aprons, boots and protective suits.

9.5.5 Respirators

The use of chemicals in labs or other situations does not usually require the use of respiratory protection. Use of respirators in laboratories is strongly discouraged except where engineering controls are not feasible or where they are being installed. Do not purchase a respirator without calling EH&S to request a hazard assessment to determine if a respirator is required.

NAU follows a respiratory protection program developed by EH&S in accordance with the Federal Respiratory Protection Standard (29 CFR 1910.134). Employees who are placed in the Respirator Program must first receive a medical exam, attend

an EH&S respiratory protection training session and undergo a fit test. Please contact EH&S, or visit the EH&S website for a copy of the NAU Respiratory Protection Program.

9.5.6 Other PPE

Other types of PPE, such as aprons, dust masks, thermal protection, coveralls, hearing protection, etc. may be required as determined by the laboratory's hazard assessment. Where needed, EH&S staff is available to assist PIs in the assessment for need and selection of proper PPE.

9.6 Safety Equipment

Various departments at NAU Facilities are responsible for the inspection, maintenance and repair of safety equipment in laboratories. It is the responsibility of the PI and other lab employees to report problems with lab equipment to the appropriate department.

9.6.1 Safety Showers and Eyewash Stations

ANSI Z358.1-1998 (American National Standards Institute) compliant safety showers and eyewashes must be located within ten seconds travel time of the chemical work area. A safety shower or eyewash station located in an adjacent room may be used if it meets the above ANSI standard and is accessible at all times. Drench hoses do not meet the ANSI requirements for safety showers or eyewashes and are designed to support, not replace, eyewashes and safety showers.

Every laboratory worker must know the location and operation of the safety shower and eyewash. All safety showers and eyewash stations must be clearly identified by signs. In hallways, signs must be visible from all directions of travel. The access to the eyewash and safety showers must be clear at all times. There must be at least a 4-foot x 4-foot clear floor area directly beneath the unit.

The building's maintenance staff will periodically test all eyewash stations and safety showers. Each unit will be tagged to identify the date of the last test. Lab staff must flush faucet mounted eyewash stations weekly. See Appendix O for an Eyewash Test Log that must be used to document this testing.

9.6.2 Eye Wash Facilities

Eye wash facilities are required in all laboratories where injurious or corrosive chemicals are used or stored, and are subject to the same proximity requirements as safety showers. OSHA has adopted the following ANSI standards for location, design and maintenance of emergency eyewash facilities:

1. Optimally, those affected must have both hands free to hold open the eye to ensure an effective wash behind the lids. This means providing eye wash facilities that are operated by a quick release system and simultaneously drench both eyes.

2. Eye wash facilities must provide the minimum of a 15-minute water supply at no less than 0.4 gallons per minute.

3. Eye wash facilities must be flushed out for five minutes at a time, once per week. A log documenting flushes is recommended (see Appendix O).

Please call EH&S for specific eye wash requirements.

9.6.3 Sprinkler Systems

Combustible items must be kept below 18 inches of the sprinkler head level. Do not block or obstruct sprinkler heads in any way. Hanging or attaching objects to sprinkler piping or heads is not permitted. Partitions cannot be erected without permission from Fire Life Safety.

9.7 Ventilation Controls

Appropriate ventilation is required for any lab space used for chemical, biological, radiological, or animal work. Additional ventilation requirements may apply depending on the type of work conducted in the lab. Ventilation controls are those controls intended to minimize employee exposure to hazardous chemicals by removing air contaminants from the work site. There are two main types of ventilation controls:

1. General (Dilution) Exhaust: a room or building-wide system that brings in air from outside and ventilates within. Laboratory air must be continually replaced, preventing the increase of air concentration of toxic substances during the workday. General exhaust systems are not recommended for the use of most hazardous chemicals.

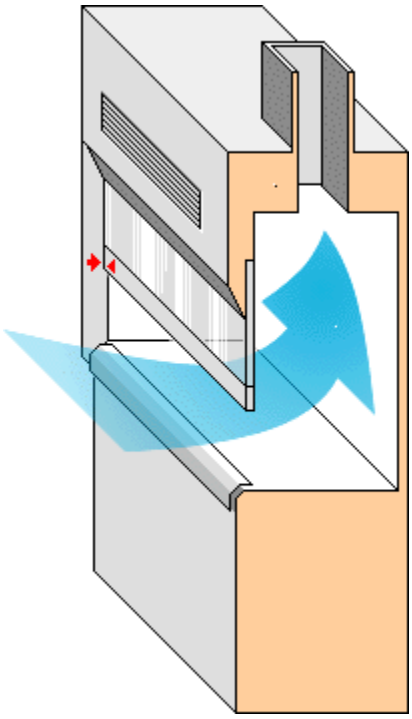
2. Local Exhaust: a ventilated, enclosed workspace intended to capture, contain and exhaust harmful or dangerous fumes, vapors and particulate matter generated by procedures conducted with hazardous chemicals.

To determine ventilation requirements, assess the SDS. Some SDS terminology, as listed below, may indicate a need for special ventilation considerations beyond general exhaust ventilation:

- use with adequate ventilation
- avoid vapor inhalation
- use in a fume hood

- provide local exhaust ventilation

9.7.1 Fume Hoods and Ventilation Systems



Ventilation systems for laboratories are normally designed to provide 6 - 12 air changes per hour at a slightly negative pressure relative to hallways and office space. It is important to keep lab doors and windows closed as much as possible for proper pressure balance and ventilation of the lab.

Chemical fume hoods are intended to remove vapors, gases and dusts of toxic, flammable, corrosive or otherwise dangerous materials. It is important for lab staff to understand how the chemical fume hood in the lab functions. All laboratory personnel must be trained in proper use of fume hoods. For complete guidelines on fume hood use see Appendix P. If there are any questions or concerns about fume hood function, please contact EH&S.

Proper Use of Local Ventilation Systems: Once a local ventilation system is installed in a work area, it must be used properly to be effective. For use of hazardous chemicals warranting local ventilation controls, observe the following guidelines:

1. Conduct all operations that may generate air contaminants at or above the Permissible Exposure Limit (PEL) or Threshold Limit Value (TLV) inside a fume hood.

2. Keep all apparatus at least 6 inches back from the face of the hood and keep the slots in the hood baffle free of obstruction by apparatus or containers. Large equipment must be elevated at least two inches off the base of the fume hood, to allow for the passage of air underneath the apparatus.

3. Do not use the hood as a waste disposal mechanism.

4. Minimize storage of chemicals or apparatus in the hood.

5. Keep the hood sash closed at all times except when the hood is in use.

6. Minimize foot traffic and other forms of potential air disturbances past the face of the hood.

7. Do not have sources of ignition inside the hood when flammable liquids or gases are present.

8. Use sash as a safety shield when boiling liquids or conducting an experiment with reactive chemicals.

9. Periodically check the airflow in the hood using a continuous monitoring device or another source of visible airflow indicator. If the airflow has changed, contact EH&S for an inspection or Facilities for repair.

The system must be checked prior to each use to assure it is operating. **Never work with hazardous chemicals if the required ventilation system is not working.**

With the sash lowered to the indicated level for proper airflow, laboratory fume hoods can also afford workers protection from such hazards as chemical splashes, sprays or fires. Sash heights are posted and updated annually on the certification sticker attached to each hood. To set the sash at the indicated level, measure from the floor of the hood, as the opening must include the area under the airfoil. See diagram in Appendix P.

If the hood's airflow alarm is sounding, the lab staff must immediately end all work in the hood, close all chemical containers and close the sash. Contact the building's maintenance department to have the ventilation system repaired. Do not mute, ignore or disconnect any fume hood alarm.

Testing and Profiling

A professional certification firm will profile each hood annually as mandated by various regulations and fire codes. The certification sticker will provide information on the type of hood, intended use and sash height settings.

Fume Hood Repairs

If a hood needs to be repaired, the appropriate maintenance group will not perform any work unless an Equipment Release process has been followed (see Appendix M). It will be the responsibility of the lab staff to stop all work in the hood that is not functioning properly, call in the work order, clear the hood of chemicals or equipment and clean the hood of any potential contamination. EH&S Radiation Safety staff will swipe test hoods used for radioisotopes before repairs are conducted.

A private firm performs hood inspections **annually.** After an inspection, hoods are passed or failed for use based on the following criteria:

1. The face velocity of air being drawn into the hood at maximum sash height is measured quantitatively in feet per minute (fpm). One measurement is taken

per square foot of face space. Hoods must have an average face velocity of 60-150 fpm, depending on their design, with 100 fpm being the ideal average face velocity.

2. The turbulence of the air is measured qualitatively by releasing smoke from a smoke tube. The hood must capture the smoke with a minimum amount of turbulence.

If the exhaust system does not pass the face velocity test and/or has excessive turbulence, it will be posted as "failed" by the inspector. The PI must contact Capital Assets and Services to have the system repaired before hazardous chemicals can be used in the hood.

If the exhaust system does pass, the inspector will post the date of inspection and will mark the hood to indicate proper sash position for optimum hood performance. The hood sash must be set at this point for procedures that could generate toxic aerosols, gases or vapors. In general, the sash height must be set at a level where the operator is shielded to some degree from any explosions or violent reactions which could occur and where optimum airflow dynamics are achieved. If a fume hood has no markings regarding sash height or inspection dates, please contact the Vendor to arrange for an inspection.

Certain types of local exhaust systems are not designed for the use of hazardous chemicals. If a local exhaust system's capability is not fully understood, check the manufacturer's specifications or call EH&S before using hazardous chemicals in the system.

Proper use of Ductless Ventilation Systems: Ductless, or portable fume hoods, which employ filtration media, may be an option to conventional local exhaust hoods. Contact EH&S for consultation before acquiring any ductless fume hood.

10.0 UTILITY SYSTEMS

Laboratory staff may not perform any modifications of any utility systems in buildings or labs. No part of the ventilation, electrical, plumbing (water and gas) may be tapped into, repaired, removed, added to or tampered with in any way. If work is required on these systems, please submit a work order to Facilities.

If there are any concerns or need to upgrade a system within a lab area, contact Capital Assets and Services (CAS) to assess the requirements and concerns.

10.1 Plumbing Systems

Flexible tubing, garden hoses and PVC piping are not acceptable as plumbing alternatives, including but not limited to tap, hot, chilled, waste water systems and

steam lines. If additional water supplies are required, contact the appropriate CAS department for installation.

Tap water must not be left flowing to cool experiments for longer than 30 minutes or left unattended. A refrigerated re-circulating system must be used to cool experiments or equipment to minimize potential damage from leaks and flooding.

Isolated or unused sinks and floor drains may be a source of foul odors if traps are dry. Please ensure that all sinks have had water periodically run into them to fill the trap. If a sink is in an isolated area and will not be used for some time, please contact CAS to inquire whether filling the trap with mineral oil would be appropriate. Mineral oil will not evaporate and is environmentally safe.

Many NAU buildings have plumbed gases, such as natural gas, air or nitrogen. These systems are regulated within the building and do not need additional regulators attached prior to use. All hoses or tubing leading from the stopcock to the use areas must be clamped and connections must be leak tested. The length of the tubing must be minimized and cannot be run across the lab, through doors or over the ceiling tiles.

10.2 Electrical Systems

The electrical demand in laboratories has grown tremendously since most buildings and labs were designed. It is imperative that the electrical systems in these buildings are not abused or overloaded. Lab staff cannot modify, install or remove electrical systems. Contact CAS to assess or modify the lab's electrical requirements.

10.2.1 Electrical Cords

Electrical cords and plugs must be inspected routinely to identify cracked insulation or broken plugs. Any equipment found with damaged cords or plugs must be removed from service until it is repaired. Wrapping broken insulation with electrical tape is not an acceptable repair method. Electrical cords can not be run across floors, under rugs, through walls, doors, windows, over ceiling tile or around sharp edges and corners where they can be damaged or cannot be inspected for damage.

10.2.2. Extension Cords

Extension cords are intended only for temporary use with portable equipment. Permanent use of extension cords is prohibited. Shop made cords with receptacle boxes may not be used, as they do not meet electrical codes. The use of multi plug electrical boxes is acceptable only if they have an internal fuse. These may not be plugged into one another in series. These must be attached to a solid surface such as a wall or table.

10.2.3 Surge Protection

The use of surge protection is recommended for all electrical equipment in all labs. These must have internal fuses and cannot be plugged into one another in series. These must be attached to a solid surface such as a wall or table.

10.2.4 Ground Fault Circuit Interrupters (GFCI)

A GFCI must be installed on all outlets located near wet areas such as sinks, showers, wash down areas, etc. A GFCI is a fast-acting device that interrupts current to protect against shocks and electrocution. GFCIs sense very small current leakages and will shut off the electricity to that outlet. Freezers, refrigerators, and other important lab equipment that requires continuous power must not be plugged into GFCI outlets.

11.0 STANDARD REPAIR/ DECOMMISSIONING PROCEDURES

Because laboratory equipment is subject to chemical, radiological, and biological contamination, EH&S has developed the Equipment Release for Maintenance/Repair, Relocation, and/or Public Sale Policy (see Appendix M). This policy describes actions that must be taken to ensure proper decontamination of laboratory equipment.

11.1 Decontamination of Equipment

When a request for equipment repair or transfer to another location is initiated, specific steps must be undertaken to ensure the safety of the employees responsible for repair or transfer if the equipment has been contaminated by hazardous chemicals. In summary, the following requirements must be met prior to any requests for maintenance, repair, relocation or release for public sale:

A. Remove chemical contaminants with an appropriate solvent or cleaning solution.
B. Once contaminants have been eliminated, fill out an "Equipment Release Form" (located in Appendix M) and place in a prominent position on the equipment to be repaired or transferred. **The equipment must have the Equipment Release Form affixed for initiation of repair or transfer.**

Appendix A: List of Definitions

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

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen (see *select carcinogen*).

Chemical means any substance, or mixture of substances.

Chemical manufacturer means an employer with a workplace where chemical(s) are produced for use or distribution.

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

Chemical Hygiene Plan means 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) meets the requirements of paragraph (e) of 29 cfr 1910.1450.

Chemical name means the scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS) rules of nomenclature, or a name that will clearly identify the chemical for the purpose of conducting a hazard classification.

Common name means any designation or identification such as code name, code number, trade name, brand name or generic name used to identify a chemical other than by its chemical name.

Container means any bag, barrel, bottle, box, can, carboy, cylinder, drum, flask, reaction vessel, storage tank, or the like that contains a hazardous chemical.

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

Designated representative means any individual or organization to whom an employee gives written authorization to exercise such employee's rights under this section. A recognized or certified collective bargaining agent shall be treated automatically as a designated representative without regard to written employee authorization.

Distributor means a business, other than a chemical manufacturer or importer, which supplies hazardous chemicals to other distributors or to employers.

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

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

Employer means a person engaged in a business where chemicals are either used, distributed, or are produced for use or distribution, including a contractor or subcontractor.

Exposure or *exposed* means that an employee is subjected in the course of employment to a chemical that is a physical or health hazard, and includes potential (e.g., accidental or possible) exposure. "Subjected" in terms of health hazards includes any route of entry (e.g., inhalation, ingestion, skin contact or absorption.)

Foreseeable emergency means any potential occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which could result in an uncontrolled release of a hazardous chemical into the workplace.

Hazard category means the division of criteria within each hazard class, e.g., oral acute toxicity and flammable liquids include four hazard categories. These categories compare hazard severity within a hazard class and should not be taken as a comparison of hazard categories more generally.

Hazard class means the nature of the physical or health hazards, e.g., flammable solid, carcinogen, oral acute toxicity.

Hazard classification means to identify the relevant data regarding the hazards of a chemical; review those data to ascertain the hazards associated with the

chemical; and decide whether the chemical will be classified as hazardous according to the definition of hazardous chemical in 29 cfr 1910.1200. In addition, classification for health and physical hazards includes the determination of the degree of hazard, where appropriate, by comparing the data with the criteria for health and physical hazards.

Hazard not otherwise classified (HNOC) means an adverse physical or health effect identified through evaluation of scientific evidence during the classification process that does not meet the specified criteria for the physical and health hazard classes addressed in this section. This does not extend coverage to adverse physical and health effects for which there is a hazard class addressed in this section, but the effect either falls below the cut-off value/concentration limit of the hazard class or is under a GHS hazard category that has not been adopted by OSHA (e.g., acute toxicity Category 5).

Hazard statement means a statement assigned to a hazard class and category that describes the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard.

Hazardous chemical means any chemical which is classified as a physical hazard or a health hazard, a simple asphyxiant, combustible dust, pyrophoric gas, or hazard not otherwise classified, in accordance with the Hazard Communication Standard (§1910.1200).

Health hazard means a chemical which is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in Appendix A to §1910.1200—Health Hazard Criteria and §1910.1200(c) (definition of "simple asphyxiant").

Immediate use means that the hazardous chemical will be under the control of and used only by the person who transfers it from a labeled container and only within the work shift in which it is transferred.

Importer means the first business with employees within the Customs Territory of the United States which receives hazardous chemicals produced in other countries for the purpose of supplying them to distributors or employers within the United States.

Label means an appropriate group of written, printed or graphic information elements concerning a hazardous chemical that is affixed to, printed on, or attached to the immediate container of a hazardous chemical, or to the outside packaging.

Label elements means the specified pictogram, hazard statement, signal word and precautionary statement for each hazard class and category.

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

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a moveable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

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

(i)

(ii)

(iii) Multiple chemical procedures or chemicals are used;

(iv) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

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

Mixture means a combination or a solution composed of two or more substances in which they do not react.

Mutagen means chemicals that cause permanent changes in the amount or structure of the genetic material in a cell. Chemicals classified as mutagens in accordance with the Hazard Communication Standard (§1910.1200) shall be considered mutagens for purposes of this document.

Physical hazard means a chemical that is classified as posing one of the following hazardous effects: Explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid, or gas); self-reactive; pyrophoric (gas, liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; in contact with water emits flammable gas; or combustible dust. The criteria for determining whether a chemical is classified as a physical hazard are in appendix B of the Hazard Communication Standard (§1910.1200) and §1910.1200(c) (definitions of "combustible dust" and "pyrophoric gas").

Pictogram means 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.

Precautionary statement means a phrase 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.

Produce means to manufacture, process, formulate, blend, extract, generate, emit, or repackage.

Product identifier means the name or number used for a hazardous chemical on a label or in the SDS. It provides a unique means by which the user can identify the chemical. The product identifier used shall permit cross-references to be made among the list of hazardous chemicals required in the written hazard communication program, the label and the SDS.

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

Pyrophoric gas means a chemical in a gaseous state that will ignite spontaneously in air at a temperature of 130 degrees F (54.4 degrees C) or below.

Reproductive toxins mean chemicals that affect the reproductive capabilities including adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring. Chemicals classified as reproductive toxins in accordance with the Hazard Communication Standard

(§1910.1200) shall be considered reproductive toxins for purposes of this document.

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or

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

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3;

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

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

Responsible party means someone who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.

Safety data sheet (SDS) means written or printed material concerning a hazardous chemical that is prepared in accordance with paragraph (g) of 29 cfr 1910.1200.

Signal word means a word used to indicate the relative level of severity of hazard and alert the reader to a potential hazard on the label. The signal words used in this section are "danger" and "warning." "Danger" is used for the more severe hazards, while "warning" is used for the less severe.

Simple asphyxiant means a substance or mixture that displaces oxygen in the ambient atmosphere, and can thus cause oxygen deprivation in those who are exposed, leading to unconsciousness and death.

Specific chemical identity means the chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.

Substance means chemical elements and their compounds in the natural state or obtained by any production process, including any additive necessary to preserve the stability of the product and any impurities deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition.

Trade secret means any confidential formula, pattern, process, device, information or compilation of information that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it. Appendix E to §1910.1200—Definition of Trade Secret, sets out the criteria to be used in evaluating trade secrets.

Appendix B: Lists of Carcinogens

Partial List of Common Laboratory Carcinogenic Substances by Class

Alkylating agents
a-Halo ethers
Bis(chloromethyl) ether
Methyl chloromethyl ether
Sulfonates
1,4-Butanediol dimethanesulfonate (myleran)
Diethyl sulfate
Dimethyl sulfate
Ethyl methanesulfonate
Methyl methanesulfonate
Methyl trifluoromethanesulfonate
1,3-Propanesultone
Epoxides
Ethylene oxide
Diepoxybutane
Epichlorohydrin
Propylene oxide
Styrene oxide
Aziridines
Ethylenimine
2-methylaziridine
Diazo, azo, and azoxy compounds
4-Dimethylaminoazobenzene
Electrophilic alkenes and alkynes
Acrylonitrile
Acrolein
Ethyl acrylate

Acylating agents
ß-Propiolactone
ß-Butyrolactone
Dimethylcarbamyl chloride

Organohalogen compounds
1,2-Dibromo-3-chloropropane

Hydrazines
Hydrazine (and hydrazine salts)
1,2-Diethylhydrazine
1,1-Dimethylhydrazine
1,2-Dimethylhydrazine

***N*-Nitroso compounds**
N-Nitrosodimethylamine
N-Nitroso-N-alkylureas

Aromatic amines
4-Aminobiphenyl
Benzidine (4, 4'-diaminobiphenyl)
α-Naphthylamine
ß-Naphthylamine
Aniline
o-Anisidine (2-methoxyaniline)
2,4-Diaminotoluene
o-Toluidine

Aromatic hydrocarbons
Benzene
Benz[*a*]anthracene
Benzo[*a*]pyrene

Natural products

Adriamycin
Aflatoxins
Bleomycin
Cisplatin
Progesterone
Reserpine
Safrole

Miscellaneous organic compounds
(including antitumor drugs)

Mustard gas (bis(2-chloroethyl sulfide
Vinyl chloride
Carbon tetrachloride
Chloroform
3-Chloro-2-methylpropene
1,2-Dibromoethane
1,4-Dichlorobenzene
1,2-Dichloroethane
2,2-Dichloroethane
1,3-Dichloropropene
Hexachlorobenzene
Methyl iodide
Tetrachloroethylene
compounds
Trichloroethylene
2,4,6-Trichlorophenol

Formaldehyde (gas)
Acetaldehyde
1,4-Dioxane
Ethyl carbamate (urethane)
Hexamethylphosphoramide
2-Nitropropane
Styrene
Thiourea
Thioacetamide

Miscellaneous inorganic compounds

Arsenic and certain arsenic compounds

Chromium and certain chromium compounds
Thorium dioxide
Beryllium and certain beryllium compounds
Cadmium and certain cadmium
compounds

Lead and certain lead compounds

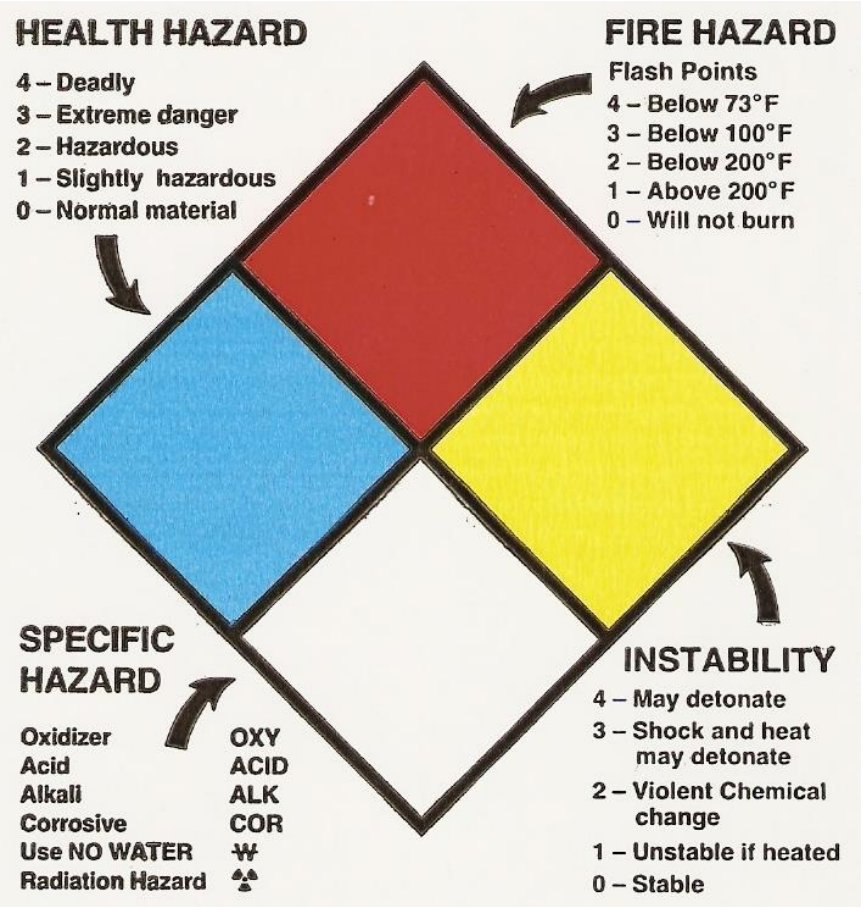
Nickel and certain nickel compounds
Selenium sulfide

Source: Prudent Practices in the Laboratory: Handling and Disposal of Chemicals

Appendix B: Chemical Labeling Systems

NFPA Hazard Warning Diamond

The National Fire Protection Association (NFPA) Hazard Warning Diamond is based on the NFPA standard 704 rating system. This standard provides a readily recognized, easily understood system for identifying hazards and their severity using spatial, visual, and numerical methods to describe the relative hazards of a material. It addresses the health, flammability, instability and other relative hazards of a material. These hazards may be long term, present short-term, or acute exposures that are mostly like to occur as a result of fire, spill, or similar emergency.



The NFPA diamond is used by first responders to quickly identify the hazards of a particular chemical or storage area. However, it is not adequate to accurately convey the hazards posed by chemicals when handled on a regular basis by laboratory workers. The Globally Harmonized System offers more precise hazard communication. A description of GHS labels and pictograms, and a comparison with the NFPA diamond follow below:

Globally Harmonized System of Labeling

GHS uses the following standardized format to identify the hazards of a product and the associated precautions to be used during handling:

Figure 1: Training Sample Label Courtesy of Weber Packing Solutions

1 - Product Identifier: the product name provided here (n-Propyl Alcohol) should match the identifier on the product's Safety Data Sheet (SDS).

2 - Signal Word: A signal word is a single word on the label used to indicate the relative level of severity of a hazard and alert the reader to a potential hazard. The signal words used are "Danger" for the more severe hazards, while "Warning" is used for less severe hazards. Here, the manufacturer has used the word "DANGER" to indicate a more severe hazard.

3 - Hazard Statements: Hazard Statements are statements assigned to a hazard class that describes the nature of the products hazard, "may cause dizziness" for example.

4 - Precautionary Statements: Statements which describe recommended measures to minimize or prevent adverse effects resulting from exposure, "keep away from heat" for example.

5 - Supplier Identification: The name, address, and telephone number of the manufacturer or supplier, in case there is a need to contact them.

6 - Pictograms: Graphical symbol intended to convey specific hazard information visually, in the case of our sample label, the manufacturer has used 3 pictograms to denote hazards. Pictograms are explained in more detail in the following section.

GHS Pictograms

Under GHS, graphical symbols called “pictograms” are used to convey specific hazards. The nine established pictograms, and their conveyed hazards, are illustrated in Figure 2.

 Irritant- May cause eye and skin irritation (redness, rash), skin sensitization, narcotic and other less serious toxic effects	 Health hazard- May cause serious and prolonged health effects on short- or long-term exposure. Includes aspiration hazards and respiratory sensitizers. Includes carcinogens, mutagens, target organ exposure, and reproductive toxicity	 Toxic- Substance which may cause life threatening effects even in small amounts and with short exposure
 Corrosives- Can cause serious skin damage and irreversible eye damage. Corrosive to metals	 Flammable- Liquids, solids, aerosols, and gases can burn if exposed to ignition source and/or heat. Can give off flammable vapors. Includes pyrophoric materials	 Oxidizer- Can burn without air, can intensify fire by providing oxygen to combustible materials
 Environmental- Toxic to aquatic organisms. Acute and chronic hazards to aquatic environments, environmental toxicity	 Explosive- May explode if exposed to shock, friction, heat, and fire. Includes organic peroxides, self-reactive materials	 Compressed gas- gases under pressure, includes liquefied gases and cryogenic liquids. Can pose asphyxiation hazard. Cylinder can pose explosion/projectile hazard if damaged

NFPA® OSHA® QUICK CARD™

Comparison of NFPA 704 and HazCom 2012 Labels

	 NFPA 704	 HazCom 2012
Purpose	Provides basic information for emergency personnel responding to a fire or spill and those planning for emergency response.	Informs workers about the hazards of chemicals in workplace under normal conditions of use and foreseeable emergencies.
Number System: NFPA Rating and OSHA's Classification System	0-4 0-least hazardous 4-most hazardous	1-4 1-most severe hazard 4-least severe hazard • The Hazard category numbers are NOT required to be on labels but are required on SDSs in Section 2. • Numbers are used to CLASSIFY hazards to determine what label information is required.
Information Provided on Label	• Health-Blue • Flammability-Red • Instability-Yellow • Special Hazards*-White *OX Oxidizers W Water Reactives SA Simple Asphyxiants	• Product Identifier • Signal Word • Hazard Statement(s) • Pictogram(s) • Precautionary statement(s); and • Name address and phone number of responsible party.
Health Hazards on Label	Acute (short term) health hazards ONLY. Acute hazards are more typical for emergency response applications. Chronic health effects are not covered by NFPA 704.	Acute (short term) and chronic (long term) health hazards. Both acute and chronic health effects are relevant for employees working with chemicals day after day. Health hazards include acute hazards such as eye irritants, simple asphyxiants and skin corrosives as well as chronic hazards such as carcinogens.
Flammability/ Physical Hazards on Label	NFPA divides flammability and instability hazards into two separate numbers on the label. Flammability in red section Instability in yellow section	A broad range of physical hazard classes are listed on the label including explosives, flammables, oxidizers, reactives, pyrophorics,combustible dusts and corrosives.
Where to get information to place on label	Rating system found in NFPA Fire Protection Guide to Hazardous Materials **OR** NFPA 704 Standard System for Identification of the Hazards of Materials for Emergency Response 2012 Edition. Tables 5.2, 6.2, 7.2 and Chapter 8 of NFPA 704	OSHA Hazard Communication Standard 29 CFR 1910.1200 (2012). 1) Classify using Appendix A (Health Hazards) and Appendix B (Physical Hazards) 2) Label using Appendix C
Other	The hazard category numbers found in section 2 of the HC2012 compliant SDSs are NOT to be used to fill in the NFPA 704 diamond.	Supplemental information may also appear on the label such as any hazards not otherwise classified, and directions for use.
website	www.nfpa.org/704	www.osha.gov **OR** www.osha.gov/dsg/hazcom/index.html

For more information:

National Fire Protection Association
www.nfpa.org
(800) 344-3555

OSHA® Occupational Safety and Health Administration
U.S. Department of Labor
www.osha.gov (800) 321-OSHA (6742)

OSHA 3678-08 2013

NFPA® OSHA® QUICK CARD™

The substance: "NOMIXUP 7042012"

To create an OSHA label per HazCom 2012:

Step 1: Perform the classification in accordance with Appendix A: Health Hazards & Appendix B Physical Hazards of 29 CFR 1910.1200 — this is where you find the criteria for each hazard class and hazard category.

Class: Flammable Gas, Category 1

Class: Carcinogen, Category 1B

Class: Specific Target Organ Toxicity (Single Exposure), Category 3

Class: Substances and Mixtures Which, in Contact with Water, Emit Flammable Gases, Category 3


Identifier: NOMIXUP 7042012

DANGER!

Hazard Statements: Extremely Flammable Gas
May Cause Cancer
May Cause Respiratory Irritation
In Contact with Water Releases Flammable Gas

Precautionary Statements: Keep away from heat/sparks/open flames/hot surfaces.-No Smoking
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Avoid breathing vapors and mists.
Wear protective gloves and eye protection.
If inhaled: Remove person to fresh air and keep comfortable for breathing.
Call poison center/doctor if you feel unwell.
Leaking Gas Fire: Do not extinguish unless leak can be stopped safely.
Eliminate all ignition sources if safe to do so.
Store in tightly closed container in a well-ventilated place, locked up.
Use outdoors or use in a well-ventilated place.
Dispose of contents in accordance with local/regional/national regulations.

XYZ Chemical Company 123 Main St. Anywhere , NY, USA 1-800-000-1111

Step 2: Gather labeling information (Pictograms, Signal Word, Hazard Statements) from Appendix C of 29 CFR 1910.1200 based on the chemical's hazard class and category.

Step 3: Create the Label

To Create NFPA 704 label:

Step 1: Collect information on hazards from applicable sections of SDS. Some SDSs may provide the NFPA diamond symbol with hazard rating numbers filled in already. **Note: Do NOT use the hazard category numbers given in section 2 of HazCom 2012 compliant SDS on 704 label!**

If the diamond is not provided on the SDS you can obtain the information under the following sections of the SDS. Note that additional information may be provided in other sections of the SDS.

- Health hazard information under Section 11
- Flammability information under Section 9
- Instability information under Section 10
- Special information under Section 9, 10, 11

Step 2: Obtain current edition copy of NFPA 704 or view on line at www.nfpa.org/704. Compare the criteria on the SDS sections as shown above with the criteria shown in Tables 5.2 (Health), 6.2 (Flammability), 7.2 (Instability) and 8.2 (Special Hazards).

Step 3: Place numbers for the degree of hazard associated with the criteria obtained in Step 2 in the correct quadrant of NFPA 704 placard.

For more information:

National Fire Protection Association
www.nfpa.org
(800) 344-3555

OSHA® Occupational Safety and Health Administration
U.S. Department of Labor
www.osha.gov (800) 321-OSHA (6742)

OSHA 3678-08 2013

Appendix D: Standard Operating Procedure (SOP) Template

(This form can be downloaded from nau.edu/ehs)

Laboratory Standard Operating Procedure

This is a template. Fill in all necessary blanks, and delete all highlighted areas when complete.

Principal Investigator (PI): Enter PI's name here **Approval #:** Enter Approval # here

PI Phone Number(s): Enter PI's phone number here

Laboratory Safety Coordinator (LSC): Enter LSC's name here

LSC Phone Number(s): Enter LSC's phone number here

Department: Click here to enter text.

1. Purpose

This standard operating procedure (SOP) is intended to provide guidance on how to safely Describe the procedure or process this SOP will address in Enter PI's name 's laboratory. Laboratory personnel should review this SOP, as well as the appropriate Safety Data Sheet(s) (SDSs), before Describe the procedure or process this SOP will address. If you have questions concerning the requirements within this SOP, contact your Principal Investigator (PI) or Laboratory Safety Coordinator (LSC).

2. Scope

[Describe when this SOP applies and to whom this SOP applies.]

3. Hazard Description

[Describe the hazards presented by the procedure or process this SOP addresses. What makes it hazardous? Provide an example, if applicable.]

4. Setup

[Describe how to safely set up the procedure or process.]

5. Personal Protective Equipment

[Describe the personal protective equipment needed to adequately protect laboratory workers when performing the process or procedure addressed by this SOP. Ensure to

specify any personal protective equipment beyond the minimum (i.e. safety glasses, lab coat, gloves, long pants and closed-toed shoes).]

6. Process

[Describe the steps needed to complete this procedure or process in a safe manner. Use as much detail as is necessary to ensure all laboratory workers can complete the procedure or experiment safely.]

7. Cleanup

[Describe how to safely end the procedure or process, clean up the process, and dispose of any waste generated.]

8. Enter Additional Section Title

[Add as many sections as necessary to adequately describe how to safely perform the procedure or process addressed by this SOP.]

Appendix E: Chemical Storage/Compatibility Guidance

Chemical Compatibility Guidelines

The following list is to be used only as a general guideline. Please refer to your Safety Data Sheets (SDS) for specific incompatibilities.

Chemical:	Incompatible with:
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric and sulfuric acid mixtures
Alkali and alkaline earth metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenic materials	Any reducing agent
Azides	Acids
Bromine	See chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metal, turpentine
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	All other chemicals
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali

Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Acids
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids and gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, and gases
Perchloric Acid	Acetic anhydride, bismuth and its alloys, alchohol, paper, wood, grease, oils
Peroxides, organic	Acids (organic or inorganic), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate see also chlorates	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals, such as sodium, lithium)
Tellurides	Reducing Agents

CHEMICAL STORAGE GUIDELINES

SOLIDS: Low tendency for reaction (when dry) most can be shelved alphabetically, exceptions:

- Sulfides must be stored away from acids
- Cyanide compounds must be segregated from acids, especially liquid acids
- Phenol crystals must be stored separately from oxidizers
- Store flammable solids away from other solids or in flammable storage cabinet

LIQUIDS: Store liquid chemicals below muster height

Acids

- Separate organic acids from inorganic acids, e.g., acetic from nitric
- Perchloric acid must be stored alone

Flammable Liquids

- The excess of 10 gallons must be stored in safety cabinets or in safety cans
- Drums of flammable solvents are not allowed in buildings.

Oxidizers

- Keep away from acids, bases, organics, and metals
- Store in cool place

Chemical waste accumulation

- As much as possible, liquid chemical wastes must be stored by compatibility
- Do not accumulate more than 55 gallons of chemical waste, or more than one quart of acutely hazardous waste (P-listed wastes)

<u>METALS:</u>

- Reactive metals (ex: potassium, sodium etc) and all powdered metal must be stored in flammable storage cabinets
- Mercury must be stored in non-breakable secondary containers and kept on a bottom shelf of a closed cabinet

Appendix F: Peroxide Forming Chemicals (Lists/Storage Guidelines)

CLASSES OF PEROXIDIZABLE CHEMICALS

A. Chemicals that form explosive levels of peroxides without concentration:

Butadiene[a]
Chloroprene[a]
Divinylacetylene
Isopropyl ether
Tetrafluoroethylene[a]
Vinylidene chloride

B. Chemicals that form explosive levels of peroxides on concentration

Acetal
Acetaldehyde
Benzyl alcohol
2-Butanol
Cumene
Cyclohexanol
2-Cyclohexen-1-ol
Cyclohexene
Decahydronaphthalene
Diacetylene
Dicyclopentadiene
Diethyl ether
Diethylene glycol dimethyl ether (diglyme)
Dioxanes
Ethylene glycol dimethyl ether (glyme)
4-Heptanol
2-Hexanol
Methylacetylene
3-Methyl-1-butanol
Methylcyclopentane
Methyl isobutyl ketone
4-Methyl-2-pentanol
2-Penten-1-ol
4-Penten-1-ol
1-Phenylethanol
2-Phenylethanol
2-Propanol
Tetrahydroforan
Tetrahydronaphthalene
Vinyl ethers
Other secondary alcohols

C. Chemicals that may autopolymerize as a result of peroxide accumulation

Acrylic acid[b]
Acrylonitrile[b]
Butadiene[c]
Chloroprene[c]
Chlorotrifluoroethylene
Methyl methacrylate[b]
Styrene
Tetrafluoroethylene[c]
Vinyl acetate
Vinylacetylene
Vinyl chloride
Vinylpyridine
Vinyladiene chloride

D. Chemicals that may form peroxides but cannot clearly be placed in sections A-C

Acrolein
Allyl ether[d]
Allyl ethyl ether
Allyl phenyl ether
p-(n-Amyloxy) benzoyl chloride
n-Amyl ether
Benzyl n-butyl ether[d]
Benzyl ether[d]
Benzyl ethyl ether[d]
Benzyl methyl ether
Benzyl 1-naphthyl ether[d]
1,2-Bis(2-chloroethoxy)ethane
Bis(2-ethoxyethyl) ether
tert-Butyl methyl ether
n-Butyl phenyl ether
n-Butyl vinyl ether
Chloroacetaldehyde diethylacetal[d]
2-Chlorobutadiene
1-(2-Chloroethoxy)-2-phen-oxyethane
Chloroethylene
Chloromethyl methyl ether[e]
ß-Chlorophenetol[e]
o-Chlorophenetol[e]
p-Chlorophenetol[e]
Cyclooctene[d]
Di(1-propynyl) ether[f]
Di(2-propynyl) ether
Di-n-propoxymethane[d]
1,2-Epoxy-3-isopropoxypropane[d]
1,2-Epoxy-3-phenoxypropane
Ethoxyacetophenone
1-(2-Ethoxyethoxy)ethyl acetate
2-Ethoxyethyl acetate
(2-Ethoxyethyl)-o-benzoyl benzoate
1-Ethoxynaphthalene
o,p-Ethoxyphenyl isocyanate
1-Ethoxy-2-propyne
4-Methyl-2-pentanone
n-Methylphenetole
2-Methyltetrahydrofuran
3-Methoxy-1-butyl acetate
2-Methoxyethanol
3-Methoxyethyl acetate
2-Methoxyethyl vinyl ether
Methoxy-1,3,5,7-cycloocta tetraene
ß-Methoxypropionitrile
m-Nitrophenetole
1-Octene
Oxybis(2-ethyl acetate)

Bis(2-(methoxyethoxy)ethyl) ether
Cyclopropyl methyl ether
3-Ethoxyopropionitrile
Oxybis(2-ethyl benzoate)
Diallyl ether[d]
2-Ethylacrylaldehyde oxime
ß,ß-Oxydipropionitrile
Bis(2-chloroethyl) ether
p-Di-n-butoxybenzene
2-Ethylbutanol
1-Pentene
Bis(2-ethoxyethyl) adipate
1,2-Dibenzyloxyethane[d]
Ethyl ß-ethoxypropionate
Phenoxyacetyl chloride

D. Chemicals that may form peroxides but cannot clearly be placed in sections A-C (Continued)

Bis(2-ethoxyethyl) phthalate
p-Dibenzyloxybenzene[d]
2-Ethylhexanal
å-Phenoxypropionyl chloride
Bis(2-methoxyethyl) carbonate
1,2-Dichloroethyl ethyl ether
Ethyl vinyl ether
Phenyl o-propyl ether
Bis(2-methoxyethyl) ether
2,4-Dichlorophenetole
Furan
p-Phenylphenetone
Bis(2-methoxyethyl) phthalate
Diethoxymethane[d]
2,5-Hexadiyn-1-ol
n-Propylether
Bis(2-methoxymethyl) adipate
2,2-Diethoxypropane
4,5-Hexadien-2-yn-1-ol
n-Propyl isopropyl ether
Bis(2-n-butoxyethyl) phthalate
Diethyl ethoxymethylenemalonate
n-Hexyl ether
Sodium 8,11,14-eicosa tetraenoate
Bis(2-phenoxyethyl) ether
Diethyl fumarate[d]
o, p-Iodophenetole
Bis(4-chlorobutyl) ether
Diethyl acetal[d]
Isoamyl benzyl ether[d]
Sodium ethoxyacetylide[f]
Bis(chloromethyl) ether[e]
Diethylketene[f]
Isoamyl ether[d]
Tetrahydropyran
2-Bromomethyl ethyl ether
m,o,p-Diethoxybenzene
Isobutyl vinyl ether
Triethylene glycol diacetate
ß-Bromophenetole
1,2-Diethoxyethane
Isophorone[d]
Triethylene glycol dipropionate
o-Bromophenetole
Dimethoxymethane[d]
p-Isopropoxypropionitrile[d]
1,3,3-Trimethoxypropene[d]
p-Bromophenetole
1,1-Dimethoxyethane[d]
Isopropyl 2,4,5-trichloro-phenoxy acetate
1,1,2,3-Tetrachloro-1,3-butadiene
3-Bromopropyl phenyl ether
Dimethylketene[f]
1,3-Butadiyne
3,3-Dimethoxypropene
Limonene
4-Vinyl cyclohexene
Buten-3-yne
2,4-Dinitrophenetole
1,5-p-Methadiene
Vinylenecarbonate
tert-Butyl ethyl ether
1,3-Dioxepane[d]
Methyl p-(n-amyloxy) benzoate
Vinylidene chioride[d]

a When stored as a liquid monomer
b Although these chemicals form peroxides, no explosions involving these monomers
c When stored in liquid form, these chemicals form explosive levels of peroxides without concentration. They may also be stored as a gas
in gas cylinders. When stored as a gas, these chemicals may autopolymerize as a result of peroxide accumulation.
d These chemicals easily form peroxides and must probably be considered under part B.
e OSHA-regulated carcinogen
f Extremely reactive and unstable compound.

Safe Storage Period for Peroxide Forming Chemicals

Description	Safet Storage Period
Unopened chemicals from manufacturer	18 months
Opened containers	
Chemicals in Part A	3 months
Chemicals in Parts B and D	12 months
Unihibited chemicals in Part C	24 hours
Inhibited chemicals in Part C	12 months[a]

[a] Do not store under inert atmosphere, oxygen required for inhibitor to function.

Sources: Kelly, Richard J., Chemical Health & Safety, American Chemical Society, **1996,** Sept, 28-36
Revised 12/97

DETECTION AND INHIBITION OF PEROXIDES
BASIC PROTOCOLS

Ferrous Thiocyanate Detection Method

Ferrous thiocyanate will detect hydroperoxides with the following test:

1. Mix a solution of 5 ml of 1% ferrous ammonium sulfate, 0.5 ml of 1N sulfuric acid and 0.5 ml of 0.1N ammonium thiocyanate (if necessary decolorize with a trace of zinc dust)

2. Shake with an equal quantity of the solvent to be tested

3. If peroxides are present, a red color will develop

Potassium Iodide Detection Method

1. Add 1 ml of a freshly prepared 10% solution of potassium iodide to 10 ml of ethyl ether in a 25 ml glass-stoppered cylinder of colorless glass protected from light (both components are clear)

2. A resulting yellow color indicates the presence of 0.005% peroxides

Inhibition of Peroxides

1. Storage and handling under an inert atmosphere is a useful precaution

2. Addition of 0.001% hydroquinone, diphenylamine, polyhydroxyphenols, aminophenols or arylamines may stabilize ethers and inhibit formation of peroxides.

3. Dowex-1® has been reported effective for inhibiting peroxide formation in ethyl ether.

4. 100 ppm of 1-naphthol effective for peroxide inhibition in isopropyl ether.

5. Hydroquinone effective for peroxide inhibition in tetrahydrofuran.

6. Stannous chloride or ferrous sulfate effective for peroxide inhibition in dioxane.

Peroxides Test Strips

These test strips are available from EM Scientific, Lab Safety Supply, and other laboratory suppliers. These strips can quantify peroxides ranging in concentration from 25 -100 ppm.

*The actual concentration at which peroxides become hazardous is not specifically stated in the literature. A number of publications use 100 ppm as a control value for managing the material safely.

Please note that these methods are BASIC protocols. Must a researcher perform one of these methods, all safety precautions must be thoroughly researched.

Appendix G: NAU Hazardous Waste Management Rules

Hazardous Waste Management Rules

1. RCRA Waste drums must be located "at or near the point of generation." (Can not pass through doors), and must be in the "direct" control of the operator. Do not move waste drums.

2. RCRA Waste drums must be closed at all times except when adding to the drum. If the waste drum has an attached funnel, the funnel must be closed and latched.

3. RCRA and Non-RCRA waste must be labeled correctly. If using a recycled container, all original markings must be obliterated. No double labels.

4. Once a waste container is full, contact the EH&S for drum removal. Do not place any containers in any hazardous waste storage area without prior approval from EH&S.

5. Empty containers that held hazardous material, must be triple rinsed (rinsate contained), markings obliterated, and made unusable before discarding. If containers cannot be rendered unusable (55-gallon steel drums, formalin plastic lined cardboard boxes, etc.), all markings must be obliterated and a completed "EMPTY" label must be affixed to the container.

6. Any container containing chemical waste must be labeled correctly, contact ORC for guidance.

Appendix H: NAU Hazardous Materials Transport Policy

Hazardous Material Transport

A **hazardous material** is any item or agent (biological, chemical, physical) which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors.

Any transport of these hazardous materials must comply with the following:

1. Chemicals (consult SDS prior to transport)
    a. Original DOT shipping container/packaging
        i. Within Buildings
            1. No additional safety requirements needed.
        ii. Between Building
            1. No additional safety requirements needed.
    b. Not contained in the original DOT shipping containers
        i. Within Buildings
            1. Must be transported by a cart with sides at least 2 inches high and/or by suitable hand carrier.
            2. Secondary containment
        ii. Between Buildings
            1. Must be transported by a cart with sides at least 2 inches high and/or by suitable hand carrier.
            2. Must be transported with secondary containment (A bottle of reagent inside a secondary unopened metal can or container with suitable absorbent material).
    c. Chemical Waste
        i. Only employees who have been trained in hazardous waste management transport can move chemical waste. Contact Environmental Health and Safety (EH&S) at nauehs@nau.edu for help

2. Biologics – BSL-1, BSL-2 and BSL-3
    a. Original DOT shipping container/packaging
        i. Within Buildings
            1. No additional safety requirements needed.
        ii. Between Building
            1. No additional safety requirements needed.
    b. Not contained in the original DOT shipping containers
        i. Within Buildings
            1. Must be transported in a sealed primary container, within a secondary container by a cart with sides and/or by hand carrier.
        ii. Between Buildings

1. Must be transported in a sealed primary container, within a secondary container that is all within a box or Rubbermaid type tub by a cart with sides and/or by hand carrier such as a cooler.
2. Must be transported with suitable absorbent material.
3. If driving on public highways – must be packed in the DOT packaging for automobile transport.

c. Level three agents and Select Agents
    i. Cannot move within, between or around buildings - please contact the Responsible Official at 523-7268 for authorization, directions and instructions. This activity requires prior approval by the NAU IBC (Institutional Biosafety Committee) and/or the CDC (Centers for Disease Control and Prevention).

d. Biologic Waste
    i. Contact EH&S for transport of biological waste.

3. Radiation
    a. Isotopes
        i. All licensed radioactive material will be transported as specified in the users' Radioactive Material Permit issued by NAU's Radiation Safety Committee.
        ii. At a minimum, all transport will use secondary containment and suitable absorbent material.
    b. Radioactive Waste
        i. Waste may only be transported by a member of EH&S.

Sources:
1. Prudent Practices in the Laboratory

.

Appendix I: Flammable Chemicals

Flammability Chart

Flash Points, Boiling Points, Ignition Temperatures, and Flammable Limits of Some Common Laboratory Chemicals

	NFPA Flam. Rating	Flash Point (°C)	Boiling Point Temp. (°C)	Ignition (°C)	Flammable Limit (% by volume of air) Lower	Upper
Acetaldehyde	4	- 37.8	21.1	175.0	4.0	60.0
Acetic Acid (Glacial)	2	39.0	118.0	463.0	4.0	19.9
Acetone	3	- 18.0	56.7	465.0	2.6	12.8
Acetonitrile	3	6.0	82.0	524.0	3.0	16.0
Benzene	2	-11.1	80.0	560.0	1.2	7.8
Carbon Disulfide	3	-30.0	46.1	90.0	1.3	50.0
Cyclohexane	3	-20.0	81.7	245.0	1.3	8.0
Diethylamine	3	-23.0	57.0	312.0	1.8	10.1
Diethyl Ether	4	-45.0	35.0	160.0	1.9	36.0
Dimethyl Sulfoxide	1	95.0	189.0	215.0	2.6	42.0
Ethyl Alcohol	3	12.8	78.3	365.0	3.3	19.0
Heptane	3	- 3.9	98.3	204.0	1.05	6.7
Hexane	3	-21.7	68.9	225.0	1.1	7.5
Hydrogen	4		-252.0	500.0	4.0	75.0
Isopropyl Alcohol	3	11.7	82.8	398.0	2.0	12.0
Methyl Alcohol	3	11.1	64.9	385.0	6.7	36.0
Methyl Ethyl Ketone	3	- 6.1	80.0	515.6	1.8	10.0
Pentane	4	-40.0	36.1	260.0	1.5	7.8
Styrene	3	32.2	146.1	490.0	1.1	6.1
Tetrahydrofuran	3	-14.0	66.0	321.0	2.0	11.8
Toluene	3	4.4	110.6	480.0	1.2	7.1
P-Xylene	3	27.2	138.3	530.0	1.1	7.0

From: Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press (1995)

Appendix J: Common Laboratory Corrosives

COMMON LABORATORY CORROSIVES

ORGANIC ACIDS
Formic Acid
Acetic Acid (Glacial)
Propionic Acid
Butyric Acid
Chloroacetic Acid
Trichloroacetic Acid
Acetyl Chloride
Acetyl Bromide
Chloroacetyl Chloride
Oxalic Acid
Propionyl Chloride
Propionyl Bromide
Acetic Anhydride
Methyl Chloroformate
Dimethyl Sulfate
Chlorotrimethylsilane
Dichlorodimethylsilane
Phenol
Benzoyl Chloride
Benzoyl Bromide
Benzyl Chloride
Benzyl Bromide
Salicylic Acid

ORGANIC BASES
Ethylenediamine
Ethylimine
Tetramethylethylenediamine
Hexamethylenediamine
Trimethylamine aq. soln.
Triethylamine
Phenylhydrazine
Piperazine
Hydroxylamine
Tetramethylammonium Hydroxide

ELEMENTS
Fluorine (gas)
Chlorine (gas)
Bromine (liquid)
Iodine (crystal)
Phosphorus

INORGANIC BASES
Ammonium Hydroxide
Calcium Hydroxide
Sodium Hydroxide
Potassium Hydroxide
Calcium Hydride
Sodium Hydride
Hydrazine
Ammonium Sulfide
Calcium Oxide

INORGANIC ACIDS
Hydrofluoric Acid
Hydrochloric Acid
Hydrobromic Acid
Hydriodic Acid
Sulfuric Acid
Chromerge™
No-Chromix™
Chlorosulfonic Acid
Sulfuryl Chloride
Bromine Pentafluoride
Thionyl Chloride
Tin Chloride
Tin Bromide
Titanium Tetrachloride
Perchloric Acid
Nitric Acid
Phosphoric Acid
Phosphorus Trichloride
Phosphorus Tribromide
Phosphorus Pentachloride
Phosphorus Pentoxide

ACID SALTS
Aluminum Trichloride
Antimony Trichloride
Ammonium Bifluoride
Calcium Fluoride
Ferric Chloride
Sodium Bisulfate
Sodium Fluoride

References :
The Foundations of Laboratory Safety, S. R. Rayburn, 1990.
Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Research Council, 1981.

Appendix K: Common Laboratory Oxidizers

COMMON LABORATORY OXIDIZERS

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

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

Appendix L: Shock Sensitive and Explosive Materials

SHOCK SENSITIVE AND EXPLOSIVE CHEMICALS

The term "shock sensitive" refers to the susceptibility of a chemical to rapidly decompose or explode when struck, vibrated or otherwise agitated. Explosive chemicals are those chemicals which have a higher propensity to explode under a given set of circumstances than other chemicals (extreme heat, pressure, mixture with an incompatible chemical, etc.). The label and SDS will indicate if a chemical is shock sensitive or explosive. The chemicals listed below may be shock sensitive or explode under a given number of circumstances and are listed only as a guide to **some** shock sensitive or explosive chemicals. Follow these guidelines:

- Write the date received and date opened on all containers of shock sensitive chemicals. Some chemicals become increasingly shock sensitive with age.
- Unless an inhibitor was added by the manufacturer, closed containers of shock sensitive materials must be discarded after 1 year.
- Wear appropriate personal protective equipment when handling shock sensitive chemicals.

acetylene
acetylides of heavy metal
amatex
amatol
ammonal
ammonium nitrate
ammonium perchlorate
ammonium picrate
azides of heavy metals
baratol
calcium nitrate
chlorate
copper acetylide
cyanuric triazide
cyclotrimethylenetrinitramine dinitrophenol
dinitrophenyl hydrazine
dinitrotoluene
ednatol
erythritol tetranitrate
fulminate of mercury
fulminate of silver
ethylene oxide
ethyl-tetryl
fulminating gold
fulminating mercury
fulminating platinum
fulminating silver
gelatinized nitrocellulose
guanyl
guanyl nitrsamino
guanyltetrazene
hydrazine
nitrated carbohydrate
nitrated glucoside
nitrogen triiodide
nitrogen trichloride
nitroglycerin
nitroglycide
nitroglycol
nitroguanidine
nitroparaffins
nitrourea
organic nitramines
ozonides
pentolite
perchlorates of heavy metals
peroxides
picramic acid
picramide
picratol
picric acid
picryl sulphonic acid
silver acetylide
silver azide tetranitromethane

Mixtures:

germanium
hexanitrodiphenyamine
hexanitrostilbene
hexogen
hydrazoic acid
lead azide
lead mononitroresEH&Sinate
lead styphnate
mannitol hexanitrate
sodium picramate
tetracene
tetrytol
trimethylolethane
trimonite
trinitroanisole
trinitrobenzene
trinitrobenzoic acid
trinitrocresol
trinitroresEH&Sinol
tritonal
tetranitrocarbazole
urea nitrate

Appendix M: Personal Protective Equipment Hazard Assessment

Personal Protective Equipment (PPE)
Hazard Assessment

Please complete the following hazard assessment for your laboratory. OSHA requires this assessment for any tasks that require personal protective equipment. Please check all activities that apply to your area. If a task is not listed that requires personal protective equipment please fill out the blank spaces at the bottom of this form. Keep this form with your Chemical Hygiene Plan (CHP) for training, reference, and documentation.

Date: _____ Department: _____

Building: _____ Room Number(s):_____

Principal Investigator: _____

Assessment Completed by: _____

Chemical Hazards			
Check All That Apply	**Task**	**Potential Hazard**	**Recommended PPE**
	Working with small volumes of corrosive liquids (< 1 liter).	Skin or eye damage	Safety glasses or goggles Light chemically resistant gloves Lab coat, closed shoe, pants
	Working with large volumes of corrosive liquids (> 1 liter), acutely toxic corrosives, or work which creates a splash hazard	Large surface area skin or eye damage, poisoning, or great potential for eye and skin damage	Safety goggles and face shield Heavy chemically resistant gloves Lab coat, closed shoe, pants, and chemically resistant apron
	Working with small volumes of organic solvents (< 1 liter).	Skin or eye damage Slight poisoning potential through skin contact	Safety glasses or goggles Light chemically resistant gloves Lab coat, closed shoe, pants

Chemical Hazards Continued			
Check All That Apply	**Task**	**Potential Hazard**	**Recommended PPE**
	Working with large volumes of organic solvents (> 1 liter), very dangerous solvents, or work which creates a splash hazard	Major skin or eye damage, or potential poisoning through skin contact	Safety goggles and face shield Heavy chemically resistant gloves Lab coat, closed shoe, pants, and chemically resistant apron
	Working with toxic or hazardous chemicals (solid or liquid).	Potential skin or eye damage, potential poisoning through skin contact.	Safety glasses (goggles for large quantities), chemically resistant gloves, lab coat, closed shoe, pants.
	Working with acutely toxic or hazardous chemicals (solid or liquid).	Great potential skin or eye damage, great potential poisoning through skin contact.	Safety goggles, appropriate heavy chemically resistant gloves, lab coat, closed shoe, pants, Coveralls and booties if necessary.
	Working with explosives.	Skin or eye damage from flying projectiles or chemicals.	Blast shield, safety goggles or full-face shield, chemically resistant gloves, lab coat, closed shoe, pants.
	Working with chemical dusts.	Skin or eye damage, respiratory damage.	Safety glasses or goggles, appropriate gloves, lab coat, closed shoes or boots if necessary, pants, Approved respiratory protection (call EH&S).

Radiological Hazards			
Check All That Apply	**Task**	**Potential Hazard**	**Recommended PPE**
	Working with solid radioactive materials or waste.	Potential cell damage, potential spread of radiaosctive materials.	Safety glasses, gloves, lab coat, closed shoe, pants.
	Working with radioactive chemicals (corrosives, flammables, liquids, powders, etc.).	Potential cell damage or spread of contamination plus hazards for the appropriate chemical hazards above.	Safety glasses (or goggles for splash hazard), light chemically resistant gloves, lab coat, closed shoe, pants. Use PPE for applicable chemical hazards above.
	Working with ultraviolet radiation.	Conjunctivitis, corneal damage, erythema.	UV face shield and goggles, lab coat, closed shoe, pants.
	Working with Laser radiation.	Retinal eye damage, skin damage.	Appropriate shaded goggles with optical density based on individual beam parameters, lab coat, closed shoe, pants. No jewelry or reflective items allowed.
	Working with infrared emitting equipment (i.e. glass blowing).	Cataracts, flash burns to cornea.	Appropriate shaded goggles, lab coat, closed shoe, pants.
Biological Hazards			
Check All That Apply	**Task**	**Potential Hazard**	**Recommended PPE**
	Working with radioactive human blood, body	Potential cell damage, potential spread of	Safety glasses (goggles for splash hazard), light latex

	fluids, or blood borne pathogens (BBP).	radioactive contaminants, or potential BBP exposure.	gloves, lab coat, closed shoe, pants.

Biological Hazards Continued			
Check All That Apply	**Task**	**Potential Hazard**	**Recommended PPE**
	Working with small volumes of human blood, body fluids, tissues, or blood borne pathogens.	Potential contaction of infectious disease, potential spread of infectious disease.	Safety glasses, light latex gloves, lab coat, closed shoe, pants.
	Working with large volumes of human blood, body fluids, tissues, or blood borne pathogens.	Increased potential for contaction of infectious disease or increased potential for spread of infectious disease.	Safety goggles with face shield, latex gloves, lab coat, closed shoe, pants. Coveralls and boot covers if necessary.
	Working with live or poisonous animals and plants.	Animal bites, stings, or infectious disease. Skin or eye damage from contact with animal or plant poisons.	Safety glasses or goggles, protective gloves, lab coat, closed shoe, pants.
	Working with animal specimens (preserved or unpreserved).	Potential exposure to infectious disease, animal toxins, or preservatives.	Safety glasses or goggles, protective gloves, lab coat, closed shoe, pants.
Physical Hazards			
Check All That Apply	**Task**	**Potential Hazard**	**Recommended PPE**
	Working with cryogenic liquids.	Major skin, tissue, or eye damage.	Safety glasses or goggles for large volumes, heavy insulated gloves, lab coat, closed shoe, pants.

	Working with very cold equipment or dry ice.	Frostbite, hypothermia.	Safety glasses, insulated gloves and warm clothing, lab coat, closed shoe, pants.

Physical Hazards Continued			
Check All That Apply	**Task**	**Potential Hazard**	**Recommended PPE**
	Working with hot liquids, equipment, open flames (autoclave, bunsen burner, water bath, oil bath).	Burns resulting in skin or eye damge.	Safety glasses or goggles for large volumes, insulated gloves, lab coat, closed shoe, pants.
	Metal arc or tungsten arc (TIG) welding.	Conjunctivitis, corneal damage, erythema, skin burns.	Appropriate shaded goggles and face shield, gloves, lab coat, closed shoe, pants.
	Instrument repair.	Eye damage from foriegn objects.	Safety glasses, no loose clothing or jewelry.
	Metal or woodworking.	Eye damage from foriegn objects, lacerations from burrs or spinters.	Safety glasses, gloves, no loose clothing or jewelry.
	Working in nuisance dusts.	Skin or eye damage, respiratory damage.	Safety goggles, appropriate gloves, lab coat, closed shoes or boots if necessary, pants, NIOSH approved dust mask or other respiratory protection (call EH&S).
	Glassware washing.	Lacerations.	Heavy rubber gloves, lab coat, closed shoes, pants.

	Working with loud equipment, noises, sounds, or alarms, etc.	Potential ear damage and hearing loss.	Ear plugs or headphones as necessary.

Other Hazards			
Check All That Apply	**Task**	**Potential Hazard**	**Recommended PPE**

Appendix N: Eyewash Test Log

Weekly Eyewash Test Log

Date Tested	Testing Done By

Appendix O: Fume Hood Guidelines

Fume Hood Operating Guidelines

Sash heights are posted and updated annually on the plaque attached to each hood.

To set the sash at the indicated level, measure from the floor of the hood, as the opening must include the area under the airfoil.

Always close the sash when running experiments and unattended operations.

To maximize hood effectiveness and minimize personal exposure to toxic vapors or gases, use fume hoods in accordance with these operational guidelines:

- ***Operate the hood at the proper sash height,*** as indicted on the profile sticker located on the front of the hood. For variable air volume or bypass hoods sash heights will not be posted. These hoods must maintain the velocity (indicated on the label) at any sash height, but sashes must be lowered to a position where they can provide additional protection from splashes, sprays, and fires.
- ***Minimize release of contaminants into the work area by*** reducing pedestrian traffic in front of hoods, particularly during hazardous experiments. Also minimize nearby disturbances, such as doors opening or closing, people walking by, and any quick motion in order to prevent cross drafts.
- ***Do not position fans or air conditioners so as to direct airflow across the face of the hood.*** This can interfere with airflow and containment of hazardous chemicals.

- ***Do not block airfoil:*** Many labs place absorbent paper on the floor of the hood and over the airfoil to catch spills. The airfoil provides airflow across the floor of the hood, especially when the sash is closed. If you use absorbent paper in the hood, please do not block the airfoil.
- ***Side panels must not be removed.*** Doing so will interfere with airflow and containment, as air will be brought into the hood from these openings. It is dangerous to use the hood in this condition. If side panels are found missing, EH&S will remove the hood from service until they are installed.
- ***Place bulky equipment away from sidewalls*** to allow airflow around the equipment.
- ***Place any bulky equipment towards the rear of the hood*** and raise it about 2 inches off the surface with blocks or bricks. This will allow airflow around and under the equipment. Equipment placed near the hood face will cause great variation in airflow. This equipment must be moved towards the rear of the hood, but do not place this equipment against the rear wall of the hood, as it will block airflow to the rear baffles. The use of riser blocks will prevent obstruction of back exhaust slots.
- ***Work as far inside the hood as possible***, at least 6 inches from the front edge with the sash face between you and task at hand. All equipment must be a minimum of 9-12 inches away from the hood face.
- ***Keep sash face clean and clear.*** To encourage use of sash as added protection against splashes, sprays, etc. keep sash face clean. If sash face must be blocked with paper for certain experiments, please take it down after the experiment is complete.
- ***Do not use the hood as a storage cabinet*** for chemicals or equipment. Materials stored in fume hoods must be kept to a minimum and stored in a manner that will not interfere with airflow. This can be accomplished by equipping the hood with perforated shelves on the side walls and/or allowing at least 3-inch spaces between containers or equipment so air can flow around them to the back exhaust slot.
- ***Place any heat-generating equipment in the rear of the hood.*** Heating devices in the hood produce convection currents that can disrupt airflow.

- ***Do not use a hood for any function it was not designed for***, such as perchloric acid, radioisotopes, etc. The generation of perchloric acid vapors requires specially designed fume hoods with wash-down systems. Failure to use a wash-down system will result in the deposit of explosive perchloric acid crystals that may detonate in the hood ductwork. Hoods used for radioisotopes must be approved by the EH&S RSO.
- ***Wear protective equipment!*** Fume hoods do not prevent accidents or chemical splashes. Personnel protective equipment (safety glasses, gloves, aprons, etc.) appropriate to the conditions must always be worn.
- ***Close sash when*** finished with hood work or **when leaving experiments or chemicals unattended!** This simple procedure has contained many fires and explosions within a hood.