Chemical Hygiene Plan

Arizona State University
Department of Environmental Health & Safety
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Environmental Health & Safety
Chemical Hygiene Plan

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Environmental Health & Safety

Chemical Hygiene Plan

Introduction and Purpose

Arizona State University continually strives to provide a learning, teaching, and research environment free from recognized hazards. The Occupational Safety and Health Administration (OSHA) regulates, 29 CFR 1910.1450 and 29 CFR 1910.132, the University and requires establishment of this Chemical Hygiene Plan (CHP) to protect employees and students from potential health hazards associated with handling, use, and storage of hazardous chemicals in laboratories. CHP includes methods designed to protect employees from the health hazards presented by hazardous chemicals and other materials used in laboratories.

Scope and Application

The purpose of this Chemical Hygiene Plan at Arizona State University is to provide chemical users basic safety information regarding the use of chemicals. It also meets the requirements of EHS 104: Laboratory Use of Hazardous Chemicals. This Chemical Hygiene Plan forms the foundation for the safe use of chemicals in the laboratory. The safe storage, use and disposal of chemicals in the laboratory require policies for the protection of students, employees, and the environment. This plan applies to employees in areas where laboratory use of hazardous materials occurs. ASU has academic, research, and clinical laboratories using hazardous chemicals and other materials. Resources and personnel have been dedicated to provide an effective program to prevent, reduce, and control hazards in the work area.

The CHP applies employees engaged in the laboratory use of hazardous chemicals. The ASU Hazard Communication "Employee Right-To-Know" Program addresses university employees engaged in non-laboratory use of hazardous chemicals, e.g., facilities maintenance and vehicle repair. In addition, the ASU Exposure Control Plan for Blood borne Pathogens is designed to protect the health of employees determined to have potential exposure to human blood and other potentially infectious materials as mandated by OSHA. Copies of these programs are available through the Department of Environmental Health & Safety website.

Permissible Exposure Limit

The ASU Chemical Hygiene Plan strives to ensure that laboratory use of OSHA regulated substances do not exceed the permissible exposure limits (PEL) specified in 29 CFR § 1910, Subpart Z. PEL refers to the eight-hour time-weighted average for airborne concentrations of hazardous chemicals. An action level is a concentration below the PEL for a specific regulated substance that requires certain actions to prevent exposures above the PEL (see definitions). If employee exposure to the OSHA regulated substances exceeds the action level (or the PEL in the absence of an action level), then the employer must comply with the substance-specific health standards specified in 29 CFR part 1910, subpart Z.

Employee Exposure Determination

Environmental Health & Safety (EH&S) will conduct or ensure sampling and monitoring activities are conducted to measure employee exposure to any hazardous chemical if there is any reason to believe exposure levels for the chemical routinely exceeds established acceptable

levels. The decision to conduct monitoring is based on review of procedures conducted in individual laboratories in response to requests received from deans, directors, chairs, laboratory safety committees, safety coordinators, laboratory supervisors and employees, or on information obtained during the laboratory registration or inspection process.

OSHA has specific mandates for several substances that may pose serious health risks to employees. ASU has established written plans and monitoring programs for those specific substances that are used in the laboratories. Each laboratory that has any of these chemicals in their inventory should contact Environmental Health & Safety to enroll in the chemical-specific monitoring programs (see program links below).

For any laboratory use of a chemical for which there is a specific OSHA health standard, EH&S may monitor for potential exposures if:

- There is a reason to believe that the exposure levels for that substance routinely exceed the action level or, in the absence of an action level, the permissible exposure limit;
- A request for monitoring is made by the laboratory supervisor or employee when there is reason to believe that the exposure levels for that substance routinely exceed the action level, or in the absence of an action level, the permissible exposure limit.

However, this is not a complete list of OSHA specific programs. For a complete list, please refer to the OSHA website or contact EH&S at ASKEHS@asu.edu or (480) 965-1823.

EH&S may recommend or conduct initial exposure monitoring when:

- When there is reason to believe that the maximum airborne concentration of a specific chemical could be above the short term exposure limit (STEL) action level or PEL; and
- The combination of chemicals could be above the STEL, action level or PEL.

Initial monitoring by direct reading methods may be conducted by EH&S. These methods include, but are not limited to, colorimetric tubes, test paper strips and direct reading vapor monitors. Active monitoring may be performed for materials which there are no direct monitoring methods. If initial monitoring reveals employee exposure over the STEL, action level or PEL, EH&S must immediately comply with OSHA exposure monitoring provisions established for the specific contaminant.

If direct measurements indicate exposures may exceed the acceptable limits, additional monitoring may be required and active testing of individual breathing zones will be conducted using accepted OSHA methods and AIHA accredited laboratories.

EH&S may not recommend monitoring if or when:

- Initial monitoring does not indicate any exposure above the action levels
- There is no source of contamination
- Monitoring does not demonstrate exposures above the ceiling or short-term action levels
- The source is noncontiguous
- If engineering and/or administrative controls have maintained exposures below action levels.

The employee must be notified in writing by posting the test results in an appropriate location within 15 working days after the receipt of results. Notification and posting will be completed by EH&S.

Responsibilities

Environmental Health & Safety (EH&S)

EH&S is responsible for ensuring regulatory compliance with the OSHA Laboratory Standard for ASU. EH&S will serve as the custodian of documents required by the standard, e.g., the ASU CHP, a copy of Title 29 Code of Federal Regulations, the OSHA Permissible Exposure Limit (PEL) listing, and the American Conference of Industrial Hygienist Threshold Limit Values (TLV) listing. EH&S will maintain a reference library and provide training equipment, supplies and materials.

Chemical Hygiene Officer (CHO)

As mandated by the standard, the chemical hygiene officer (CHO) is appointed by the university. The CHO provides technical guidance in the development and implementation of the provisions of the CHP. The CHO will serve as a liaison between the university and regulatory agencies relative to Laboratory Standard compliance issues. The CHO for ASU is the EH&S Assistant Director for Occupational Health & Safety.

Deans, Directors, and Chairs

- Deans, directors, and chairs are responsible for establishing and implementing department information and training programs for their respective areas, as outlined in the Employee Information and Training section of this plan. Delegation of this responsibility to the Principle Investigator (PI), laboratory supervisor or manager or Compliance Officer and/or safety committee is acceptable.
- Deans, directors and chairs are also responsible for assuring that laboratories are properly registered according to EH&S policy. Additionally, Deans, directors and chairs must assure that deficiencies found during inspections are addressed within the required 30 day turnaround time. Delegation of this responsibility to the Principle Investigator (PI), laboratory supervisor or manager or Compliance Officer and/or safety committee is acceptable.
- Deans, directors and chairs are also responsible for assuring that each principal investigator that sets-up, moves or vacates a laboratory contact EH&S to ensure the proper transportation and disposition of hazardous materials. Delegation of this responsibility to the Principle Investigator (PI), laboratory supervisor or manager or Compliance Officer and/or safety committee is acceptable.

Compliance Officers

Arizona State University's, Environmental Health & Safety Management Policy (EH&S MP) calls for the University to be a model of quality in environmental health and safety. Critical links in the development of this level of quality are the college or department Compliance Officers (CO). COs undergo special training and develop a unique relationship with Environmental

Health & Safety. They serve as the major source of coordination for those activities which support the EH&S MP and the activities of the Policy and Operations Committees. The CO has delegated authority from the Provost, Dean, Chair or Director for managing environmental health and safety activities in the Campus/Institute or department including the authority to establish processes investigate complaints and/or incidents and audit the performance of ASU employees performing their duties. The CO has the responsibility to report questionable activities and unresolved compliance issues to the delegating authority as well as to the Director of EH&S. For more information on the CO program please visit the EH&S website at http://www.asu.edu/uagc/EHS/documents/compliance_officer_duties.pdf .

Safety Committee

The EH&S Operations Committee provides oversight for the all EH&S programs at ASU. See EHS 005: Management Policy for more information on the set up and function of the EH&S Operations Committee.

Where individual departments establish safety committees, the primary function should be to provide peer review of all internal safety audits, training reviews, accident investigations, and other safety related actions as deemed necessary by the department and in accordance with regulatory and EH&S mandates. Each department's safety committee should consist of faculty and/or other department representatives, as appointed by the dean, director, or chair. Department Compliance Officers should serve on any safety committee established within that department. Department safety committees may implement laboratory safety practices specific to their department but must at a minimum meet the requirements of this CHP and all applicable EH&S policies. Established safety committees should consult the CHO on any matter involving interpretation and application of EH&S policies to laboratories.

The laboratory supervisor or designee is the principal investigator assigned to the laboratory. It is the responsibility of each principal investigator to understand the provisions of this plan and ensure that employees are aware of dangers involved in the handling and use of hazardous chemicals or materials. The principal investigator is required to notify EH&S if there is reason to believe that an employee's exposure level to a hazardous chemical routinely exceeds the action level (or in the absence of an action level, the permissible exposure limit).

Principal investigators must ensure that MSDSs are available for every chemical in the workplace. Employee training in the use and comprehension of the MSDS files must be provided. Supervisors using outside vendors or contractors are responsible for obtaining MSDSs from them and forwarding copies to the designated safety coordinator. The supervisor is also responsible for informing any visitor, contractor or vendor of the hazards of the chemicals used in the area they are working in or visiting.

Employees

Employees are any paid personnel, including graduate students on stipends. Employees are responsible for understanding the hazards involved with chemicals they use. They must be familiar with the location and contents of the MSDS file in their work area. They must consult their supervisor if they are unsure of the safe handling, use, and storage of the hazardous chemicals. All applicable safety training must take place before the employee begins working in the laboratory or where hazardous materials are in use.

Vendors, Contractors and Visitors

Laboratory supervisors are responsible for ensuring that vendors, contractors, and visitors understand the dangers involved in the area they are working in or visiting. The vendors, contractors, and visitors will have all necessary personal protective equipment provided for them by the laboratory or by contractors' management.

Laboratory Registration

Laboratory registration is the process the university uses to maintain laboratory emergency contacts and information, develop and maintain laboratory chemical inventories, and establish laboratory safety inspections for ensuring compliance with the ASU Chemical Hygiene Plan. The laboratory's annual registration review and update provides each laboratory the opportunity to perform a self-evaluation of their laboratory safety using the laboratory safety inspection checklist.

The laboratory registration process requires the principal investigator of the laboratory or her/his designee (laboratory supervisor, coordinator, manager, etc.) to annually complete and submit a current chemical inventory, and Responsible Party Information (RPI) sheet to EH&S. Additionally, the PI or designee must provide EH&S with the names of the employees of the laboratory so that safety training records can be checked. EH&S will issue an updated laboratory registration upon receipt of the chemical inventory, training records and RPI. The registration sign displays the laboratory emergency contact personnel, location of the MSDS, potential hazards located in the laboratory, and displays the "diamond shaped" National Fire Protection Association (NFPA) 704 hazard ratings. General information is also listed on the registration that is helpful during emergencies. While the registration is in process, a copy of the completed RPI should be posted at the laboratory entrance. When the registration process is complete, an updated registration sign will be mailed to the laboratory responsible party or designee for posting at the laboratory's entrance. The registration issued date on the sign signifies the anniversary date to re-register the laboratory.

A. General guidelines on registering traditional lab space:
Individual rooms should be registered if:

1. The room is entered from any public access or entrance area (corridor, hallway, etc.)
2. The room is accessed through an adjoining area or room *and* contains special hazards (BSL2, BSL3, OSHA regulated carcinogens, lasers, x-rays, radiation, noise hazards, dust hazards etc.)

If the room is part of a series of rooms (i.e. 123, 123A, 123B etc.), only the primary room needs to be registered as long as the other rooms do not contain special hazards or conditions.

***Example*:** Room LSZ 123 includes rooms LSZ 123A and LSZ 123B. Only LSZ 123 needs to be registered unless LSZ123A and LSZ 123B contain special hazards or conditions. If LSZ 123A or LSZ 123B contains special hazards or conditions, then that room will need to be registered separately and in addition to room LSZ 123.

B. General guidelines on registering open shared lab space:

An open shared lab is a large lab room shared by multiple research groups, an example are labs in Biodesign and ISTBI buildings.

1. Each Principal Investigator(s) or designee must complete a separate RPI for their group.
2. Principal Investigator(s) or designee can collaborate and submit a cumulative chemical inventory for the open lab (preferred method). Alternately, each researcher can submit their chemical inventory separately.

Sub rooms in the open shared lab space must be registered separately if they contain special hazards or conditions or if the room has its own entrance from a public access or entrance area (corridor, hallway, etc.) (See item A., above.)

Responsible Party Information Sheet

In order to obtain laboratory registration, the principal investigator or designee must submit a Responsible Party Information (RPI) sheet to EH&S annually or as changes occur. The RPI sheet identifies emergency contacts, locations of emergency equipment, and any hazards or special concerns specific to each laboratory. EH&S will maintain this information in a database and has developed a sign for posting outside each laboratory to be used by emergency response personnel. An RPI is available at the EH&S website Forms section. The RPI sheet contains instructions for completing the sheet. Appendix B also provides information. EH&S is available to provide assistance if you have questions regarding completing the RPI.

Chemical Inventory

Each laboratory will at least annually, conduct and document a chemical inventory and submit the inventory to EH&S. Identification of all chemicals, including non-hazardous items, in the laboratory is required. The chemical inventory must include a complete account of the chemicals used or stored in the work area or laboratory, *including compressed gases, paints, oils, insecticides, herbicides, fertilizers, aquarium products and cleaning products etc.* The inventory requires notation of the following items:

- An alphabetized list of the complete International Union of Pure and Applied Chemistry (IUPAC) names or acceptable trade chemical names for each chemical (abbreviations are not acceptable)
- Chemical Abstracts Service (CAS) number
- Quantity stored
- Location of chemical use or storage (room number)
- National Fire Protection Association (NFPA) Hazard Ratings (found on the MSDS sheets)

A chemical inventory template is located at the EH&S website.

Unused or unwanted chemicals should be submitted for disposal in accordance with the ASU Hazardous Waste Management Guidelines available at http://uabf.asu.edu/ehs_hazmat_compliance_guidelines.

EH&S Lab Registration Follow up Process

1. Initial request for Responsible Party Information Sheet (RPI) and Chemical Inventory complete with NFPA hazard ratings is sent to the Principal Investigator or designee. EH&S will provide links to or attachments of forms necessary for proper registration.
2. If no response within 30 days of original request, a second request will be sent via email. If the laboratory conducts research, the Director of Research Integrity & Assurance at ASU's Office for Research and Sponsored Projects Administration (ORSPA) will be included on the email as well as any applicable safety committee, senior compliance officer, or department designee.
3. If no response after 30 days (total of 90 days after original request) the information and request is forwarded to the Dean, Director or Chair of the department and an immediate inspection of the laboratory will be scheduled.

Chemical Hygiene Plan Requirements

Provisions of the ASU CHP are outlined in the following sections. Individual department or colleges may develop their own version of a CHP provided it meets the requirements of the ASU CHP at a minimum. Additionally, individual laboratories are encouraged to develop Laboratory Specific CHPs utilizing the guidelines provided in Appendix D of the ASU CHP. Access to the ASU written CHP and the entire OSHA standard requiring the CHP (29 CFR 1910.1450) is available for all employees through the EH&S website. Copies of the CHP can be obtained by contacting EH&S or by downloading the document from the EH&S web site. A copy of the CHP should be available in the work area. A copy of the OSHA standard is available at the OSHA website.

Laboratory Check-in/Check-out

EH&S 405: Laboratory Check-in/Check-out requires that each department or principal investigator that sets-up, moves or vacates a laboratory contact EH&S to ensure the proper transportation and disposition of hazardous materials and to ensure that chemicals, hazardous waste, biological waste, and other materials are not left behind in the laboratory. EH&S will conduct a Lab Move Assessment or Lab Check-out Inspection and will offer guidance and assistance to ensure that all hazardous material regulations are addressed and satisfied. This allows EH&S to ensure proper decontamination of equipment and minimizes waste generation by managing the methods hazardous materials are packaged for waste handling or reuse. Chemicals no longer needed but still useable can be offered to other laboratories to prevent them from becoming hazardous waste and to ensure their safe handling and use. The Environmental Protection Agency (EPA) requires that all chemicals must be properly identified and that waste is disposed of correctly.

The check-in/check-out procedures should include the following:

- All chemicals, including hazardous waste, must be identified and properly labeled.

- All containers of hazardous waste, including out of date and/or unusable chemicals, must be disposed of in accordance with ASU's Hazardous Waste Management Compliance Guidelines.
- Any usable chemicals should be transferred to another laboratory. The department safety coordinator should be contacted for assistance in determining which chemicals can be issued to another laboratory.
- Biological waste and sharps must be disposed of in accordance with ASU's Biological Hazardous Waste Compliance Guidelines.
- Compressed gas cylinders must be removed from the laboratory by contacting Laboratory Stores Purchasing at 965-9079.
- Any radioactive waste, radioactive materials and radiation producing equipment must be removed from the laboratory. These activities should be coordinated through ASU's Office of Radiation Safety.
- All refrigerators fume hoods and cabinets should be cleaned.
- Any outdated/unusable equipment should be sent to the ASU Surplus Property Department.

Each department is responsible for making certain that hazards are removed from the laboratory prior to any principal investigators departure from the laboratory. The principle investigator should establish an inspection process and sign-off on any laboratory transfer. Following these procedures will ensure EPA compliance and that the incoming faculty member has a clean, healthy environment in which to work.

Material Safety Data Sheets (MSDS)

The responsible person for the laboratory must maintain a collection of MSDSs for all chemicals in the laboratory and ensure that they are readily accessible to all laboratory employees. The location and availability of the collection must be shared with the laboratory employees. The collection can either be maintained as an electronic or paper copy. If the MSDS's are to be stored electronically, they should not require internet access to obtain. Additionally, MSDS's should be placed in a file that is accessible to all users and should not be placed in any file that is password protected. The collection should include the laboratory's current chemical inventory and MSDSs arranged alphabetically.

Hazard Analysis

A hazard analysis is a step-by-step review of the procedures used by a laboratory and functions to predict hazards and risks to personnel and property and the environment. The hazard analysis also assists in defining control methods to prevent exposures to hazards. The analysis should include the following:

- Laboratory Use Evaluation
- Chemical Use Evaluation
- Personal Protective Equipment Evaluation

- Pollution Prevention Analysis
- Evaluation for the need of a Prior Approval form

Hazard analysis should be based on information provided during laboratory safety training however EH&S is available to assist with this endeavor. Hazard analysis should take place during the laboratory registration process or may be scheduled as part of the laboratory inspection. PIs and Lab Managers should conduct preliminary hazard assessments on any new process or procedure.

Chemical and Laboratory Use Evaluation

Each laboratory should conduct a chemical and laboratory use evaluation. EH&S can provide assistance. This evaluation is a general description of the function of the laboratory identifying the hazards and the pollution prevention/waste minimization goals. Laboratory activities that need chemical and laboratory use evaluations are:

- Research laboratories
- Academic laboratories using procedures for teaching purposes
- Projects that require approval by the Institutional Biosafety Committee

A general description of the function of the laboratory includes:

- A basic outline of all procedures, i.e. standard operating procedures
- A list of types of reactions expected
- A list of all reagents including maximum volumes and concentrations
- MSDS information availability
- A pollution prevention/waste minimization analysis
- A hazards analysis with hazard management techniques
- Expected methods of chemical and biological waste disposal

This information demonstrates ASU's efforts to eliminate hazards in the laboratory and our commitment to minimize hazardous wastes generated by the university. If upon review, the information is insufficient or procedures are deemed too hazardous, EH&S may require further analysis or safety measures.

Products of the research and the chemicals remaining after research is complete are also subject to review by EH&S. The researcher must contact EH&S to determine if the chemical waste produced by the experiment is disposable. There are many rules and regulations controlling disposal of wastes, and this creates many different costs and management problems. The analysis includes a justification for producing these wastes. Analyzing these materials before experimentation begins can prevent many problems not envisioned at the completion of the experiment.

Personal Protective Equipment (PPE)

Laboratory management, with the assistance of EH&S should perform a hazard evaluation to determine which PPE are required for each laboratory task. PPE requirements are covered during laboratory safety training and must be followed by all employees and visitors to the laboratory. Any deviations from the PPE requirements covered during laboratory safety training are to be documented with a PPE hazard assessment analysis. Standard operating procedures should include methods used to implement control measures for reducing employee's exposures to hazardous chemicals and materials. Engineering controls, the use of PPE, and hygiene practices are possible control measures. PPE assessment forms may be downloaded from EH&S and additional information can be obtained by reviewing the OSHA Personal Protective Equipment Standard, 29 CFR § 1910.132.

PPE is required to be used at all times while in the laboratory and includes, but may not necessarily be limited to:

- Safety goggles or face shield
- Laboratory coat or other suitable clothing (long sleeved shirt and long pants)
- Closed-toe shoes

PPE required to be used at all times when handling particularly hazardous chemicals, reproductive toxins, carcinogens, and sensitizers in the laboratory includes, but is not limited to:

- Appropriate gloves
- Approved respirators in the absence of adequate ventilation, e.g., glove boxes or fume hoods
- Hearing protection devices may be required if noise hazards are present in the laboratory.

Pollution Prevention Analysis

Pollution prevention analysis is the systematic review of laboratory procedures which use hazardous chemicals in order to reduce volume and toxicity of waste and to prevent the release of substances into the environment. Replacing hazardous chemicals with less hazardous or non-hazardous chemicals is the most efficient way to reduce waste and minimize pollution potential. *No chemicals of any kind are allowed in the trash or down the drain.* All laboratories must be accountable for all hazardous chemicals and materials to make sure they are not released into the air, sewer, or ground. The safest and most efficient way to dispose of hazardous chemicals is to have wastes picked up by on-campus hazardous waste management services.

Pollution prevention analysis requires the researcher to review all processes and to identify those chemicals that can be substituted by less hazardous chemicals. Researchers must be able to justify to EH&S and the Arizona Department of Environmental Quality (ADEQ), the use and volumes of hazardous chemicals used in their laboratories.

Prior Approval

This process involves the identification of hazards, management of risk and evaluation of pollution prevention/waste minimization. Prior approval is accomplished by completing an ASU

Prior Approval Form and submitting it to EH&S. A copy of the completed forms should be kept at the laboratory for review by EH&S safety inspectors or safety committees.

Specific procedures to be considered for this process may materials that are highly dangerous. Highly dangerous materials include:

- Reactive, peroxidizable, and explosive chemicals
- Select carcinogens
- Reproductive toxins
- Highly toxic chemicals
- Sensitizers

Specific examples of these chemicals can be found Appendix C.

Considerations for health and safety should include:

- Use of specific containment devices such as fume hoods or glove boxes
- Procedures for safe removal of waste materials
- Decontamination procedures
- Specific training for personnel
- Establishment of a designated and labeled work area. The area must be identified by signs warning any persons in the area of the hazards of the materials in use. Additional specific considerations for designated areas may include locking doors, buffer zones, and special authorizations.

An alternative to this process is Hazard Analysis discussed previously on page 11 of this plan. For questions regarding this process please contact CHO at EHS@asu.edu or (480) 965-1823.

Laboratory Safety Equipment

Ventilation and Fume Hoods

Laboratory procedures must be conducted using adequate ventilation or other engineering controls such as glove boxes, fume hoods and safety cabinets. All laboratory fume hoods, glove boxes, special ventilation areas and biological safety cabinets must perform to measurable efficiencies. Laboratory work is prohibited where general room ventilation is inadequate. General laboratory ventilation guidelines are located within the ASU Capital Programs Management Group Design Guidelines and ANSI\AIHA Z9.5-2003 American National Standard Laboratory Ventilation guideline. Refer to the ASU EH&S Chemical Fume Hood User Guide for proper use of chemical fume hoods.

All laboratory fume hoods, glove boxes, special ventilation areas and biological safety cabinets must be monitored by qualified personnel. Fume hoods should be monitored at least annually by measuring the face velocity and other appropriate performance testing by qualified personnel. Call EH&S for questions or to schedule your annual fume hood maintenance. Daily fume hood monitoring must be conducted by laboratory personnel and is accomplished by noting before beginning work in a hood that airflow is evident.

Other special ventilation devices must be certified by outside contractors annually. The laboratory must keep records of all certifications. If the ventilation device is not working within expected efficiencies, the laboratory must repair the device before conducting work in it.

Aside from the daily operator check of airflow, employees must check hoods to ensure that exhaust slots, pressure alarms, and other features are set properly and that they are in good working order. Operators must report all problems with fume hoods to the laboratory supervisor immediately. Hood maintenance and proper use includes:

- Daily check for airflow
- Maintain good housekeeping
- Hood must not be used for permanent storage of chemicals or other storage
- Hood must display a current performance testing sticker
- Contacting ASU Facilities Management for fume hood repair when face velocity is less than 80 feet per minute (FPM) or greater than 120 FPM or when daily airflow check shows an obvious drop

Eyewashes and Safety Showers

All laboratories in which hazardous and corrosive chemicals are used should have direct access to eyewash stations and safety showers. General guidelines are located within the ASU Capital Programs Management Group Design Guidelines. American National Standards Institute (ANSI Z358.1 2004) provides detailed information regarding the installation and operation of emergency eyewash and shower equipment.

- Employees who may be exposed to hazardous materials shall be instructed in the location and proper use of emergency shower (and eyewash) units (p.10).
- For a strong acid or caustic (greater than or equal to 1 Molar in concentration) the eyewash should be immediately adjacent to the hazard (p.11).
- Where the hazard is not a corrosive, one intervening door can be present so long as the door opens in the same direction of travel as the person attempting to reach the emergency equipment and the door is equipped with a closing mechanism that cannot be locked to impede access to the equipment (p.27).
- Personal wash units (portable or squeeze bottle type eyewashes) and drench hoses are considered supplemental to emergency eyewash and shower equipment (p.7).
- Plumbed shower (and eyewash) equipment shall be activated weekly for a period long enough to verify operation and ensure that flushing fluid is available. Note: The intent is to ensure that there is a flushing fluid supply at the head of the device and to clear the supply line of any sediment build-up that could prevent fluid from being delivered to the head of the device and minimize bacterial contamination due to sitting water (p.10).
- The eyewash unit shall be designed, manufactured and installed in such a manner that, once activated, it can be used without requiring the use of the operator's hands (p.10).

- The eyewash units shall provide flushing fluid to both eyes simultaneously (p.10).
- Eyewash nozzles shall be protected from airborne contaminants. Whatever means is used to afford such protection, it shall not require a separate movement by the operator when activating the unit (p.10).
- The shower (and eyewash) shall be located on the same level as the hazard and the path of travel shall be free of obstructions that may inhibit the immediate use of the equipment (p.9).
- Emergency eyewash and shower equipment should be available for immediate use, but in no instance should it take an individual longer than 10 seconds (or 55 feet) to reach the nearest facility… A door is considered to be an obstruction (p.27).
- Showers should be checked routinely to assure access is not restricted and the start chain is within reach.
- Plumbed and self-contained shower equipment shall be capable of delivering flushing fluid at a minimum of 75.7 liters per minute (20 gpm) for a minimum of 15 minutes (p.8).
- The flow through the safety showers should be tested periodically to ensure sufficient flow (approximately 60 gallons per minute.) (EH&S contractors conduct annual inspections and place stickers on each unit indicating the date of testing.)
- The valve shall remain open without the use of the operator's hands until intentionally closed. The valve shall be simple to operate and shall go from "off" to "on" in 1 second or less (p.8).

<u>Fire Safety Equipment</u>

Fire safety equipment must be easily accessible to the laboratory and include a fire extinguisher (type ABC) available within 50 feet, and may include fire blanket or automatic extinguishing systems. Fire extinguishers are inspected annually by EH&S staff.

Employee Information and Training

Laboratories must utilize the written information and training program as outlined herein. OSHA states that all laboratory employees must be provided with information and training to ensure communication of the hazards present in their work area in order to prevent work-related injuries and illnesses. Training must be provided for new employees *prior to working in the laboratory* or when a new hazardous chemical is introduced into the work area. The laboratory supervisor must assure that training of all laboratory employees occurs. Employee training must consist of:

- Details of the Chemical Hygiene Plan
- Identification of personnel responsible for certain aspects of the CHP
- Information to help employees understand and read labels and MSDSs
- Locations of the MSDSs and other mandated documents
- Physical and health hazards of common chemicals

- Protective procedures from the hazards, e.g., work practices, PPE and emergency procedures
- Methods and procedures to detect the presence of or release of a chemical in the work area (CO monitors etc.)
- Methods and procedures for reporting accidents.

EH&S provides laboratory safety training sessions at all ASU campus locations. Training registration takes place via ASU Human Resources Learning Performance and Solutions. EH&S can provide specific training for individual departments or principal investigators upon request. Call EH&S to arrange for special training sessions at 480-965-1823. PIs or laboratory supervisors must provide further laboratory specific safety training to employees relative to the specific hazards associated in their laboratory (i.e. chemicals and equipment). PIs or laboratory supervisors must also provide laboratory specific safety training relative to specific hazards associated in their laboratory to non-employees (students) working within their laboratories. Specialized training or training for employees with special needs will be provided to employees when necessary. Please include provisions for employees with special needs within your building and/or department specific emergency preparedness plans. The emergency preparedness plan template is available at http://uabf.asu.edu/ehs_emergency_plan_template.

This type of training can be performed by a department provide it meets the requirements of this CHP. Call EH&S for consultation and approval before conducting such training.

Each employee must complete training as identified on the EH&S Training Determination Table available at http://uabf.asu.edu/ehs_training_table. ASU policy EHS 108-01: Health and Safety Training provides discussion of the required health and safety procedures. This includes initial and annual training for all employees involved in activities covered under this CHP.

Labeling

Hazardous chemicals in the laboratory must be properly and adequately labeled. Laboratory supervisors must assure that all chemicals have labels with legible writing that indicate the name(s) of the container's contents. The label must be written in English using acceptable IUPAC chemical names. Abbreviations are acceptable on labels only if the laboratory maintains a document clearly visible and in the vicinity of the container that indicates the chemical name represented by the abbreviations. Labels must include any applicable NFPA hazard warnings, concentration, and date of last peroxide test (if the material is a peroxide former after exposure to oxygen such as with ethyl ether). See Appendix E for more details.

Each container of a hazardous chemical received from the manufacturer with a label must have information that gives appropriate identification and hazards of that chemical. The name and address of the chemical manufacturer or distributor must also be on the label. If a container arrives without the manufacturer's label, an appropriate label must be affixed to it. Labels must not be removed, except under the following conditions:

- Container is immediately relabeled
- Chemical in the container is removed, a new type of chemical is placed in the container and the container relabeled with the identity of the new chemical.

Special Labeling Practices

- If it is not practical to label a container, appropriate information may be placed on a sign next to the container
- Chemicals that are time-sensitive or that produce peroxides must be dated indicating the date storage began
- Chemical substances developed by the laboratory and for which there is no known written hazard information, use the following procedures:

  If the chemical developed by the laboratory is produced exclusively for the laboratory's use (new compounds and drugs), the laboratory must determine if the substance is hazardous:

  - If the substance is hazardous, then the laboratory must label the containers as such, and indicate those hazards on the label
  - If the laboratory is unable to determine the hazards, it must label the chemical as if it were hazardous
  - If the chemical developed by the laboratory is produced for use by another company, the laboratory supervisor must develop a MSDS for that chemical substance

Material Safety Data Sheets (MSDS)

MSDS's must be readily available to laboratory employees for each hazardous chemical used in the work area. The MSDS must contain the following information:

- Chemical and common name
- If a mixture:

  - Chemical and common name of ingredients that are health hazards

  - Chemical and common name of ingredients that are physical hazards
- Physical and chemical characteristics (vapor, pressure, flash point and color)
- Physical hazards, including potential for fire, explosion, and reactivity
- Health hazards, including signs and symptoms of exposure and medical conditions recognized as being aggravated by exposure
- Primary routes of entry into the body
- OSHA Permissible Exposure Limit (PEL), the Threshold Limit Value (TLV), and any other exposure limit used or recommended by the manufacturer
- Indication if the chemical is a carcinogen or potential carcinogen
- Handling procedures including hygienic practices and recommended protective measures during release clean-up
- Personal protective equipment, engineering controls, and work practices
- Emergency and first aid procedures

- MSDS preparation date
- Name, address, and telephone number of the MSDS preparer

All of the above categories must be completed even if no relevant information is found. The same MSDS may be used for several chemicals if they contain similar hazards and ingredients. If additional information concerning a chemical becomes available it must be added to the MSDS within three months.

The laboratory supervisor must make provisions to provide copies of the MSDS to individual employees. Copies of the MSDS must be available to any designated representative of the employee, or OSHA officer, upon their request. The laboratory supervisor must be notified if a non-employee requests a copy of a MSDS.

To ensure that a MSDS is available in each work area utilizing hazardous chemicals, the following procedures should be followed:

- Request a MSDS from each manufacturer when ordering, using or testing new hazardous chemicals
- Designate a person to be responsible for forwarding all MSDSs to the safety coordinator
- All university departments using outside vendors to do work in their areas must require that vendors have MSDSs available

Departments may have their primary copies of MSDSs stored electronically provided all affected employees know the location of and can access the files. Although it is expected that labs will use the internet to acquire MSDS sheets, it is not acceptable to have a list of internet links to MSDS sheets as a collection.

Eating, Drinking, Smoking and Use of Cosmetics

Many respected institutions including the National Research Council, the Arizona Radiation Regulatory Agency and the Centers for Disease Control and Prevention agree that eating, drinking, smoking, gum chewing, applying cosmetics, and taking medicine in laboratories where hazardous chemicals and materials including unsealed sources of radioactive materials are used must be strictly prohibited. Food, beverages, cups, and other drinking and eating utensils are not to be stored in areas where hazardous chemicals and materials or radioactive materials are handled or stored. Additionally, contact lenses should not be worn and are not to be handled in locations where hazardous materials are present.

Each Departmental Dean, Director, Chair or their designee may designate areas within laboratory facilities where these activities are permitted. Prohibitions related to the use hazardous materials in these locations must be communicated to all laboratory personnel and the requirement must be enforced.

Refrigerators, freezers, ovens, microwaves and similar appliances in laboratories not intended for use with food or beverage to be used for human consumption must be labeled with the terms "NOT FOR USE OF FOOD" or equivalent. Similar appliances in designated locations within laboratories intended for use with food or beverage to be used for human consumption must be labeled "FOR FOOD USE ONLY" or equivalent. Areas with refrigerated food for animal use must be labeled as "FOOD FOR ANIMAL USE ONLY" or equivalent.

Shipping and Receiving Hazardous Materials / Dangerous Goods (HM/DG)

No person may receive a HM/DG without function-specific training. Training must be documented and must be include included in the employee's EH&S training records. No person may ship or offer for shipment HM/DG unless that person has received certified 16-hour US DOT training for hazardous materials. Additionally, shipments or offers to ship HM/DG by air also require certified International Air Transport Association (IATA) regulations training. All training must be current per regulation, must be documented, and must be included in the employee's EH&S training records. The shipping function may be completed by a properly trained and certified third-party freight forwarder if one is available. Shipping or an offering for shipment shall include any outbound or inbound shipment to or from ASU being made on behalf of or for ASU. This includes but is not limited to, shipments of HM/DG from off-campus locations or persons to any campus location or person, or to any permanent or temporary ASU-affiliated off-campus location or person. For more information see EHS 406 .

Minors in Laboratories

EHS 116: Minors in Laboratories prohibits anyone under the age of 18 from entering an ASU laboratory. Exceptions include minors that are participating in an organized educational program that has been approved by the head of the academic unit where the program will take place. Additional exceptions must be approved by EH&S, or by Student Affairs. The purpose of the policy is to ensure that persons under the age of 18 have approval to be in a laboratory, are under proper supervision and receive appropriate training. A parental consent form available through the EH&S and IRB websites is required for minors actually working in a laboratory. Mentoring programs and tours are allowed but approval is required from EH&S and the Departmental Dean Director or Chair. Exceptions to this policy such as those associated with frequent tours of laboratories or educational programs must be approved by the EH&S Director. Please contact the EH&S office at ASKEHS@asu.edu or (480) 965-1823 for more information on this exemption.

Use of Respirators

Respirator use may be necessary in order to maintain exposure levels below permissible limits or short term exposure limits. EH&S can help you determine the necessity for respirator use by evaluating your individual circumstances. Employees may request an evaluation by contacting EH&S or your department's safety committee. Respiratory protection users must comply with the ASU Respiratory Protection Plan and includes compliance related to all types of respirators and dust masks. Respirator equipment will be provided at no cost to employees by the specific department.

Use of Hearing Protection Devices

Hearing protection devices, such as earmuffs or earplugs may be necessary to maintain employee exposure to noise below OSHA's permissible exposure limits. Departments may request a noise evaluation by contacting EH&S. Any employee using hearing protection devices must comply with the ASU Hearing Conservation Program.

Medical Consultations and Medical Examinations

Employees working with hazardous chemicals will be provided medical attention including any follow-up examinations that the examining physician determines necessary, under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical exposure which may have occurred in the laboratory
- Where monitoring reveals an exposure level routinely above the action level, or in the absence of an action level, the PEL for an OSHA regulated substance for which there are prescribed exposure monitoring and medical surveillance requirements
- Whenever there is a spill, leak or other release resulting in a potential hazardous chemical exposure of an employee above the PEL or action level
- Examinations will be conducted under the direct supervision of a licensed physician and provided at no cost or loss of pay to the employee.

ASU will provide the physician with the following:

- The identity of the hazardous chemicals to which the employee may have been exposed
- A description of the conditions under which the exposure took place, including any quantitative data if applicable
- A description of the signs and symptoms the employee is exhibiting

After the examination, the physician will submit a written opinion to EH&S that must include the following:

- Any recommendations for medical follow-up
- The results of the medical examination and associated tests
- Any medical condition revealed that would place the employee at increased risk as a result of exposure to a hazardous chemical found in the work place
- A statement by the physician that the employee has been informed of the results of the examination and any medical condition that may require further treatment or examination
- The written opinion will not reveal specific findings of diagnosis unrelated to the occupational exposure.

Hazardous Waste Management

Laboratory operations that produce waste chemicals are considered as producing hazardous waste. Hazardous waste is regulated by The Arizona Department of Environmental Quality (ADEQ). All laboratory personnel who produce hazardous waste are required to manage their waste according to ASU's Hazardous Waste Management Compliance Guidelines. State and federal law require the university to manage its hazardous waste. Failure to manage hazardous waste properly may result in criminal prosecution and heavy fines.

All laboratory employees who physically place hazardous waste into designated hazardous waste containers are required to complete Hazardous Waste Management training either in classroom or using the web-based training available through EH&S.

Broken Glass

The following is the procedure recommended for handling broken glass. If the broken glass involves blood, microorganisms or bioresearch materials, please review the following link: http://www.asu.edu/uagc/emergency/response_guide.html#biological. If a potentially hazardous chemical is involved please review this link: http://www.asu.edu/uagc/emergency/response_guide.html#hazardous. If only broken glass is an issue, then the glass should be carefully picked up using forceps or broom and dust pan and placed in a container such as a card board box (or other designated substantial container such as a plastic container designated for broken glass) and clearly labeled as broken glass. Please do not place broken glass in ordinary trash containers as it presents a potential risk to those that need to handle it.

Emergency Procedures

Laboratory personnel must be aware of the provisions for emergency procedures and preparedness. Emergency procedures and preparedness include actions or contingencies for:

- Evacuations due to fires, chemical spills, and other situations
- First aid
- Procedures for use of special ventilation areas
- Shut down and lock-out during evacuations
- Location of emergency equipment (showers and eyewashes)

Protocols for handing emergencies are outlined in the ASU Emergency Response Guide and Arizona State University Emergency Operations Manual. Laboratories must have their own written plan detailing their specific emergency procedures.

Accident and Near Miss Reporting

Supervisors must submit accident/near miss reports to EH&S for any accident or near miss situation. Employees will be free from any reprisals for reporting accidents. Accident/Near Miss reports, corrective actions and suggestions regarding possible improvements can be help safety committees as they strive to improve future laboratory safety. To report an incident related to an employee, visitor or student in regards to an injury, illness or near miss refer to the EH&S website and fill out the Accident/Near Miss/Quality Improvement Report. EHS 115: Incident Reporting and Investigation policy

Inspections and Compliance

Each Department should establish a system for communicating health and safety issues to employees. The Compliance Officer program previously described should be considered as one method to assist in ensuring effective communication of EH&S issues and programs.

EH&S will conduct laboratory inspections determining individual laboratory compliance with the CHP as identified in Appendix B. Provisions for additional employee protection for work

with particularly hazardous substances including "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity will be addressed during this process. Inspections may be performed in conjunction with the department's periodic audit conducted by a Compliance Officer and/or safety committee members. Inspection reports will document inconsistencies with the CHP and opportunities for improvement. A report identifying deficiencies and areas for improvement will be directed to the laboratory's Principal Investigator, and any applicable safety committee, senior compliance officer, or department designee. These items must be corrected within 30 days of receipt of the laboratory inspection report. If the items cannot be corrected in that timeframe, the Principal Investigator must submit a written corrective action plan detailing the expected corrections and estimated date of completion within the same 30 days. The Principal Investigator may designate a responsible party to submit the report. Any inspection finding posing eminent danger (likely to cause a serious hazard, injury, disability or death) must be corrected immediately.

Note: Identical deficiencies noted on subsequent inspections of the same area will be reported to the Chemical Hygiene Officer for review and possible follow-up with the dean, director or chair of the department.

Lab Inspection Follow up Process

1. EH&S will send the laboratory inspection report and request for corrective action plan for the deficiencies noted therein. EH&S will request a "Read Receipt" with the email.
2. If no response is received within 30 days of the report, EH&S may as a courtesy, telephone the Principal Investigator of the laboratory with a reminder. EH&S will send a second request via email and request a "Read Receipt." If the laboratory conducts research, the Director of Research Integrity & Assurance at ASU's Office for Research and Sponsored Projects Administration (ORSPA) will be included on the email as well as any applicable safety committee, senior compliance officer, or department designee.
3. If no response is received after a total of 60 days from receipt of the inspection report, the information will be forwarded to the Dean, Director or Chair of the department for follow up.

Safety inspections generate information regarding laboratory health and safety matters. Safety committees may determine a need to conduct their own regular periodic audits of the work areas to evaluate work practices and identify potential hazards. When this approach is taken, these inspections must be presented to EH&S for review. Departmentally generated checklists of inspection requirements should include at a minimum, all of the recommendations on the EH&S inspection checklist and must be approved by EH&S. Once approved, they may be used in place of any scheduled inspection identified in Appendix B.

Program Evaluation

Program evaluation is to be conducted annually by the CHO and reviewed with the EH&S operations committee along with any metrics maintained related to the program. This review should be in the form of a systems audit and based upon the effectiveness of the CHP. The EH&S Operations Committee may direct the CHO to propose modifications to existing EH&S

policy or initiate new policies. Any changes to EH&S policies affecting the CHP will result in an update to the CHP.

Record Keeping

Required documentation and records are kept to demonstrate compliance with applicable laboratory standard mandates. EH&S uses CHP directives to collect all applicable information regarding these mandates. This information is used to complete reports, questionnaires and permits to various federal, state and local agencies. Copies of these reports and the associated information collected through inspections and submittals by laboratories are kept on file by EH&S.

Departments must maintain records required by this plan. Records of inspections conducted by the department should be sent to EH&S and include the name of the name of the inspector, the date, any unsafe conditions found, and any corrective actions taken.

Safety committees should document training activities, whether conducted in classes, safety meetings, or one-on-one job safety training sessions. Safety committees should keep records of who was trained, who did the training, when the training occurred and what training occurred.

EH&S maintains records detailing employee exposure monitoring. These records provide an accurate account of measurements taken to monitor employee exposures if the employee is exposed to any chemical contaminant above the action level. These records must be kept for 30 years past the date the employee ceases work at ASU.

The Student Health Center maintains records detailing employee medical consultations, including an accurate report of examinations, tests, and written opinions by the attending physician. These records must be kept for 30 years past the date the employee ceases work at ASU. Records must be available to employees or their representatives only. The physician's written opinion concerning occupational exposure is available to ASU.

Spill Prevention and Contingency

The basis of a CHP follows the reasoning of the National Environmental Policy Act (NEPA) legislation. NEPA calls for an analysis of the projects impact on the environment, referred to as an environmental impact statement. The purpose of this program is to encourage the laboratory's chemical users to investigate their impact on the environment. The project needs to be reviewed for consequences in the following areas:

- The health and safety of personnel due to chemical use
- Exposure of the employees to the chemicals, including:
    - Analysis of the need for medical monitoring for employees
    - Training requirements for chemical use in laboratories
- The impact of the research on the property and nearby community:
    - The impact of the products of the research on the hazardous waste disposal program
    - Efforts in analyzing procedures to reflect pollution prevention mandates

    - The impact of the research in user fees and/or permitting requirements; and
- An analysis of the energies involved
    - An emergency contingency analysis, including job hazard analysis or fault analysis

Information discovered by applying EH&S techniques and hazard analysis techniques must be applied by the laboratory supervisor in maintaining a safe laboratory.

Related Documents

Biological Hazardous Waste Compliance Guidelines

Hazardous Waste Management Compliance Guidelines

Hearing Conservation Program - PDF

Respiratory Protection Program - PDF

Appendix A

Definitions

ACGIH - American Conference of Governmental Industrial Hygienists an organization of professional personnel in governmental agencies or educational institutions engaged in occupational safety and health programs. ACGIH develops and publishes recommended occupational exposure limits (see "TLV") for hundreds of chemical substances and physical agents.

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

Acute - Severe, often dangerous conditions in which relatively rapid changes occur.

Acute Exposure - Indicates a single, brief exposure to toxic substances. Effects, i.e., adverse effects on the human body, if any are evident soon after the exposure and come quickly to a crisis.

Alloys - A mixture of metals (such as brass), in some cases a metal and a non-metal.

Ambient Temperature - Temperature of the immediate surroundings.

Appearance/Odor - The color, physical state at room temperature, size of particles and characteristics of the material. Odor is described in comparison to common familiar "smells".

Asphyxiant - A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants, such as nitrogen, either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

Aspiration Hazard - danger of drawing a fluid into the lungs, causing an inflammatory response to occur.

Assistant Secretary - The Assistant Secretary of Labor for Occupational Safety and Health, US Department of Labor, or designee.

Auto ignition Temperature - Lowest temperature at which a flammable gas or vapor-air mixture will ignite from its own heat source or other contacted heat source.

Boiling Point - Temperature at which vapor pressure of a liquid equals atmospheric pressure.

C.A.S. Number - The number assigned to chemicals or products by the Chemical Abstracts Service.

Carcinogen - A substance or agent capable of causing or producing cancer.

Catalyst - A substance which changes the speed of a chemical reaction but undergoes no permanent change itself. An example of a catalyst is the platinum used in automotive catalytic converters on the exhaust system.

Chemical Hygiene Officer - 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 CHP. This definition is not intended to place limitations on the position description or job classification that the designated individual must hold within the employer's organizational structure.

CHP – (Chemical Hygiene Plan) a written program developed and implemented by the employer. It sets forth procedures, equipment, personal protective equipment and work practices that:

(i) Are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace, and

(ii) Meet the requirements of CFR 29 1910.1450.

Chronic Effect - An adverse effect on a human or animal in which symptoms develop slowly over a long period of time or recur frequently.

Combustible - A substance capable of fueling a fire. Also a term used to classify certain liquids on the basis of their flashpoints. Also see "flammable".

Combustible Liquid - Any liquid having a flashpoint at or above 100^0F (37.8^0C), but below 200^0F (93.3^0C), except any mixture having components with flashpoints of 200^0F (93.3^0C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Compressed Gas -

(i) A gas or mixture of gases in a container, having an absolute pressure exceeding 40 psi at 70^0F (21.1^0C) or

(ii) A gas or mixture of gases in a container, having an absolute pressure exceeding 104 psi at 130^0F (54.4^0C) regardless of the pressure at 70^0F (21.1^0C) or

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

Corrosive or Corrosive Material - As defined by the Department of Transportation (DOT), a corrosive material is a liquid or solid that causes visible destruction or irreversible alterations in human skin tissue at the site of contact or in the cases of leakage from its packaging, a liquid that has a severe corrosion rate on steel.

Cutaneous - Pertaining to or affecting the skin.

Decomposition - Breakdown of a material or substance (by heat, chemical reaction, electrolysis, decay or other processes) into simpler substances.

Dermal - Pertaining to or affecting the skin.

Designated area - 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 or a device such as a laboratory hood.

Dyspnea - Shortness of breath, difficult or labored breathing.

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

Employee - An individual employed in a laboratory work place who may be exposed to hazardous chemicals in the course of his or her assignments.

Erythema - A reddening of the skin.

Evaporation Rate - The ratio of time required to evaporate the same volume of a reference liquid (ether). A high ratio means a slower evaporation rate.

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

Exposure Limit - Limit set to minimize occupational exposure to a hazardous substance. Recommended occupational exposure limits used are American Council of Governmental Industrial Hygienists' Threshold Limit Values (TLV's) and Occupational Safety and Health Administration Permissible Exposure Limits (PEL's).

Extinguishing Agents - Agent(s) suitable for controlling or putting out a fire, when properly applied.

Flammable Limits - The range of a vapor/gas concentration in air that will burn or explode if an ignition source is present.

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

(i) Aerosol, flammable means an aerosol that, when tested by the method described in 18 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening

(ii) Gas, flammable:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) Liquid, flammable: Any liquid having a flashpoint below 100 F (37.7^0C), except any mixture having components with flashpoints of 100 F (37.7^0C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) Solid, flammable: A solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical must be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint - The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79))-for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100^0F

(37.8^0C), that do not contain suspended solids and do not have a tendency to form a surface film under test or

(ii) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79))-for liquids with a viscosity equal to or greater than 45 SUS at 100^0F (37.8^0C), or that contain suspended solids, or that have a tendency to form a surface film under test or

(iii) Setaflash Closed Tester (see American National Standard Method for Test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

Organic peroxides, which undergo auto accelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

General Exhaust - Removal of contaminated air from a large area by an air circulation or exchange system.

Generic Substance - A substance identified by its general chemical name and/or formula.

Hazard Communication Program - The written program employers must develop and use. This program specifies employee training for routine and emergency use of all potentially hazardous chemicals in the workplace. It also specifies details pertaining to chemical labels, chemical storage, MSDS, and the complete list of all hazardous chemicals in the workplace.

Hazardous Chemical - A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems and agents which damage the lungs, skin, eyes, or mucous membranes. Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

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

Highly Toxic - A chemical which has been found through testing of laboratory animals to cause death when exposed at certain levels.

(i) A chemical is highly toxic to ingest if it has a median lethal dose (LD50) of less than 50 mg/kg. This means that 50 percent of the test animals (rats) died when given an oral dosage of 50 milligrams for each kilogram of body weight.

(ii) A chemical is highly toxic to touch if it has a (LD50) rating of less than 200 mg/kg, meaning that 50 percent of the lab animals (rabbits) die after having continuous skin contact at that dosage for 24 hours or less.

(iii) A chemical is highly toxic to breathe if it has a (LC50) rating of less than 200 PPM for gas or vapor and a 2 mg/m^3 for dust, fume, or mist when exposed for an hour or less.

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

Incompatible - Materials which could cause dangerous reactions from direct contact with one another are described as incompatible.

Ingestion - The drawing of a substance into the body (stomach) through the nose, mouth, and breathing passages, in the form of a gas, vapor, fume, mist, or dust.

Inhalation - The drawing of a substance into the body (lungs) through the nose, mouth, and breathing passages, in the form of a gas, vapor, fume, mist, or dust.

Irritant - A substance which will cause an inflammatory response or reaction of the eye, skin, or respiratory system, following single or multiple exposures.

Laboratory – A laboratory is defined as a facility or room where the use of potentially hazardous chemicals, biological agents or sources of energy (i.e. lasers, high voltage, radiation, etc.) used for scientific experimentation, research, or education.

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

Laboratory-type hood - A device located in a laboratory, enclosed 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 - Handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale"

(ii) Multiple chemical procedures or chemicals are used

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

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

LC50 - Lethal Concentration 50 the concentration in air that causes the death of 50% of the test animals. The concentration is expressed in mg/liter, mg/m^3.

LD50 - Lethal Dose 50 a single dose of material which on the basis of laboratory tests is expected to kill 50% of a group of test animals. The material may be administered by mouth (oral) or applied to the skin (dermal or cutaneous). The dose is expressed in g\kg of body weight.

LEL - Lower Explosive Limit The lowest concentration of a gas or vapor in the air that can produce ignition or explosion.

Local Exhaust – A local exhaust system is used for capturing and exhausting contaminants from the air to point where the contaminants (gases, particulates) are released. Not to be confused with "general exhaust".

Medical consultation - 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.

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

Mechanical Exhaust – Mechanical exhaust systems use a powered device, such as a motor-driven fan or air/street venturi tube, for exhausting contaminants from a workplace, vessel, or enclosure.

Narcosis - Stupor or unconsciousness caused by exposure to a chemical.

Neutralize - To render chemically neutral or harmless, e.g., neither acid nor base, to counteract the activity or effect, the addition of a base (sodium hydroxide) to an acid (hydrochloric acid) results in water and a salt (sodium chloride), thus the acid has been "neutralized" or rendered harmless.

Odor Threshold – An odor threshold is the minimum concentration of an airborne, toxic substance whose odor is detectable to the average individual. Depending on whether it is above or below the substance's TLV, it may be indicative of whether additional ventilation is required.

Oral - of, through, pertaining to, or affecting the mouth.

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

OSHA – (Occupational Safety and Health Administration of the U.S. Department of Labor)

OSHA is a federal agency with safety and health enforcement authority for most of U.S. industry and business.

Oxidizer - Department of Transportation defines oxidizer or oxidizing material as a substance that yields oxygen readily to stimulate the combustion (oxidation) of organic matter. Chlorate (CLO_3), permanganate (MnO_4) and nitrate (NO_3) compounds are examples of oxidizers.

PEL - Permissible Exposure Limit an exposure limit established by OSHA's regulatory authority. PELS may be expressed as either a time weighted average (TWA) limit or a maximum concentration exposure limit.

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

Polymerization - A chemical reaction in which a large number of relatively simple molecules combine to form a large chainlike molecule. A hazardous polymerization is a reaction which takes place at a rate which releases large amounts of energy.

Ppm - Parts per million a unit for measuring the concentration of a gas or vapor in contaminated air. Ppm is also used to indicate the concentration of a particular substance in a liquid or solid.

Protective laboratory practices and equipment - 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 – A pyrophoric is a chemical which ignites spontaneously with air at 130^0F or less.

Respiratory Protection - Devices for use in conditions exceeding set exposure levels when properly selected, maintained and worn by the user will protect the users' respiratory system from exposure to airborne contaminants by inhalation.

Reproductive toxins - Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

SCBA - Self-contained breathing apparatus.

Select carcinogen - Any substance which meets one of the following criteria:

1. It is regulated by OSHA as a carcinogen or
2. 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
3. It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions) or
4. 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.

Sensitizer - A substance, which on first exposure, causes little or no reaction in man or test animals, but which on subsequent exposure(s) may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form of the problem in the industrial setting, although respiratory sensitization to a few chemicals has been known to occur.

Solubility in Water - The percentage of a material (by weight) that will dissolve in water at a specific temperature.

NEGLIGIBLE LESS THAN 0.1%

SLIGHT 0.1 TO 1.0%

MODERATE 1 TO 10%

APPRECIABLE MORE THAN 10%

COMPLETE SOLUBLE IN ALL PROPORTIONS

Solvents - A substance which dissolves another substance.

Special Ventilation Areas – A special ventilation area is an Environmental room, isolation room, cold room, clean room, or incubator.

Specific Gravity - The specific gravity is the ratio of the weight of a volume of material to the weight of an equal volume of water usually at 60^0F.

Systemic - Spread throughout the body, affecting many or all body systems or organs, not localized in one spot or area.

TLV - Threshold Limit Value (exposure limit for a specific substance as per ACGIH). TLV is a measure of exposure to inhalation only.

TLV "Skin" - This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the particular chemical through the skin and eyes. Thus, the protection of large surface areas of skin should be considered to prevent skin absorption so that the TLV is not invalidated.

Target Organ - The specific organs or body systems that sustain hazardous effects from a toxic chemical, either long or short-term. Target organs could be the liver, kidney, central nervous system or skin.

Toxic - A substance which has a median lethal dose (LD50) of 50 to 500 mg/kg for ingestion, from 200 to 1,000 mg/kg within a 24-hour period for contact and from 200 to 2,000 PPM gas or vapor for inhalation.

UEL - Upper Explosive Limit - The highest concentration of a gas or vapor in air that can produce ignition or explosion.

Unstable (Reactive) – An unstable or reactive chemical can go through vigorous polymerization, decomposition or condensation. This process occurs when the chemical undergoes shock or changes in pressure or temperature.

Vapor Density - The ratio of the density of a substances vapor to the density of another substances vapor, usually air. A vapor density of greater than one means that the substance is heavier than air.

Vapor Pressure - The pressure exerted by vapor, in confinement, over its liquid as it accumulates at a constant temperature.

Water reactive - A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Appendix B

EH&S Laboratory Inspection Process

The following laboratory inspection process was approved by the EH&S Operations Committee May 24, 2006.

1. **Purpose** – To define the roles, responsibilities, and process for the EH&S general laboratory safety inspection at ASU campuses.

2. **Internal Reference**
   - **a.** ASU Chemical Hygiene Plan
   - **b.** EHS 104 Laboratory Use of Hazardous Chemicals
   - **c.** ASU Laboratory Security AGI Project 0447A

3. **External Reference**
   - **a.** OSHA 29 CFR Part 1910.1450

4. **Definitions**
   - **a.** Laboratory Manager – ASU employee responsible for laboratory operations and the employees who work in the lab, usually a Principal Investigator (PI)
   - **b.** EH&S – Environmental Health & Safety
   - **c.** Risk Categories – Defined by ASU EH&S Risk Categories

5. **Equipment – Materials**
   - **a.** EH&S Laboratory Safety Inspection Database
   - **b.** EH&S Laboratory Safety Inspection Checklist

6. **Responsibility**
   - **a.** EH&S Laboratory Inspection Program Manager
     - Coordinate inspections of ASU Laboratories
     - Report metrics of inspections
     - Designate laboratories to be inspected
     - Oversee communication of inspection results to laboratory managers (P.I., Department Heads, etc.)
     - Track completed inspections
     - Maintain EH&S inspection database
   - **b.** EH&S Employees
     - Inspect laboratories and provide results as directed by EH&S Laboratory Inspection Program Manager
     - Provide support to Laboratory Managers where applicable
   - **c.** Laboratory Managers
     - Correct and respond to inspection findings as determined by EH&S inspection reports
   - **d.** Compliance Officers
     - Coordinate development and collection of annually updated laboratory chemical inventories to provide to EH&S
     - Assist with correcting deficiencies as determined by EH&S inspection reports and follow-up

7. **Procedures**

- **a.** Laboratories to be inspected are designated by EH&S Laboratory Inspection Program Manager
- **b.** Laboratory inspections for high risk labs will be performed annually at a minimum
- **c.** EH&S inspector examines an area by physically walking through the location with EH&S Laboratory Safety Inspection Checklist
- **d.** EH&S Inspection Team or individual EH&S employee note deficiencies in work areas. The Laboratory Safety Inspection Checklist is to be used for guidance, but additional identified safety, health, and environmental deficient issues may be noted as deficiencies.
- **e.** Results of inspection are submitted to the EH&S Laboratory Inspection Program Manager
- **f.** EH&S Laboratory Inspection Program Manager (or designee) enters information into the EH&S Laboratory Inspection Database and sends reports to designated Laboratory Manager
- **g.** Laboratory Manager is responsible for correcting deficiencies or designating a responsible party to make the corrections
- **h.** Laboratory Manager may contact EH&S for support, when applicable
- **i.** Laboratory Manager notifies EH&S Laboratory Inspection Program Manager when actions are completed
- **j.** If appropriate, EH&S will contact the Laboratory Manager for follow-up of non-completed identified deficiencies. If the EH&S does not receive a response within 30 days of initial lab inspection report generation, a follow-up notification will be sent to the Laboratory Manager, Department Chair, College Dean, and Vice-President of Research.
- **k.** Compliance Officers coordinate development and collection of annually updated laboratory chemical inventories to provide to EH&S
- **l.** EH&S Laboratory Inspection Program Manager tracks metrics and reports as necessary

8. Forms

- **a.** EH&S Laboratory Safety Evaluation Checklist
- **b.** Chemical Inventory Template
- **c.** Responsible Party Information Sheet (RPI)
- **d.** EH&S Safety Registration Placard

9. Laboratory Registration Signage

EH&S Laboratory Registration Signage update will be issued to each laboratory that returns a completed laboratory inspection report, current chemical inventory (preferably in alphabetical order including compressed gas cylinders and biological agents), and RPI.

10. Records

- **a.** EH&S inspection database, 2 year retention minimum

The following Risk Categories were approved by the ASU Compliance Officer Operations Committee October 8, 2008.

ASU EH&S Risk Categories

Risk Categories	Areas Defined (Examples ONLY not all inclusive)
1 **(Low)**	Areas with general hazardous chemicals that do not have special risks. This defines the majority of laboratories. Examples: 1. Biosafety Level One (BSL1) laboratories 2. Labs with small useable amounts of chemicals 3. Classroom teaching labs (Academic teaching) 4. Lasers (Class 1, 2, 3A)
2 **(Moderate)**	Areas considered special risk laboratories. These labs use and store particularly hazardous chemicals (select carcinogens, reproductive toxins, and highly toxic chemicals.) Examples: 1. All radioisotopes (use and storage) 2. Radiation producing equipment (X-rays, accelerators) 3. Biosafety Level Two (BSL2) containment laboratories with Non-Select Agents 4. Lasers (Class 3B, 4) 5. Large volumes of chemicals in storage (flammable cabinets etc.) 6. High voltage electrical equipment (>600 volts) 7. DEA Controlled Substances
3 **(High)**	Areas with extremely hazardous activities and chemical or material use including highly sensitive areas where highest risk conditions exist. Examples: 1. Select Agent laboratories and Biosafety Level Three (BSL3) facilities 2. Labs performing research with vertebrate animals 3. Laboratories with security related equipment requiring passwords or security related entries (Select Agent, other highly sensitive or regulated areas) 4. Highly toxic gases or pyrophoric materials or gases (any quantity) 5. Areas whose grant applications require environmental and safety certification

"Carcinogens" are chemicals which cause cancer. For the purpose of the CHP, chemicals which are known carcinogens include those which: are regulated by OSHA as carcinogens (29 CFR 1910); are listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program, or are listed under group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs.

"Reproductive toxins" are chemicals which affect the reproductive capabilities including chromosomal damage (mutagens) and effects on the fetuses (teratogens). Examples of signs and symptoms include birth defects and sterility. Examples of chemicals which are reproductive toxins include lead and DBCP (dibromochloropropane).

"Highly toxic" are chemicals which have an average lethal dose of:

Ingestion: LD_{50} of less than 50 mg/kg body weight when administered orally to albino rats;

Skin Contact: LD_{50} of less than 200 mg/kg body weight when administered by continuous dermal contact over a 24 hour period to albino rabbits, or

Inhalation: LC_{50} of less than 200 parts per million of gas or vapor or 2 mg/l of mist, fume, or dust, when administered continuously by inhalation for one hour to albino rats.

Extremely Hazardous Activities – a short list of chemicals/activities that are difficult to control and have lethal potential, or could trigger a life-shortening disease, in one low, level exposure, or could cause a lethal event (e.g., explosion). This list is evolving but will likely include highly toxic, pyrophoric and carcinogenic gases, toxic gases with poor warning properties, beryllium, methyl mercury, etc.

Appendix C

List of Dangerous Chemicals

Highly Reactive Chemicals

Air-Reactive Chemicals

Air reactive chemicals can spontaneously and violently react with air, and most are pyrophoric, meaning that they spontaneously ignite with air. These chemicals should be stored tightly in an inert atmosphere or in an inert liquid. Some examples of air reactive chemicals may include, but are not limited to:

Alkyl aluminum compounds	Hydride
Aluminum	Magnesium
Barium Hydride	Nickel
Cesium	Potassium
Diborane	Sodium Amide
Diethyl zinc	Titanium
Diisobutyl aluminum	Zirconium
Dimethyl arsine	Zinc

Water-Reactive Chemicals

Certain chemicals react with water to evolve heat and flammable or toxic gases and should be stored and handled so that they do not come in contact with liquid water or water vapor. Common water reactive laboratory chemicals may include, but are not limited to:

Acetic anhydride	Lithium
Acetyl chloride	Metallic peroxides
Aluminum phosphide	Metallic phosphides
Aluminum tribromide	Sodium
Calcium carbide	Sodium hydride
Chlorosulfonic Acid	Sodium oxide
Diborane	Titanium tetrachloride

Shock-Sensitive Compounds

Common classes of shock sensitive laboratory chemicals are listed below which have potential for producing a violent explosion when subjected to shock or friction.

- Acetylenic compounds, especially polyacetylenes, haloacetylenes, and heavy metal salts of acetylenes (copper, silver and mercury salts are particularly sensitive)
- Acyl nitrates
- Alkyl nitrates, particularly polyol nitrates such as nitrocellulose and nitroglycerine

- Ammine metal oxosalts: metal compounds with coordinated ammonia, hydrazine or similar nitrogenous donors and ionic perchlorate, nitrate, permanganate, or other oxidizing group
- Azides, including metal, nonmetal and organic azides
- Chlorite salts of metals, such as silver chloride or mercuric chloride
- Diazo compounds such as cyanamide
- Diazonium salts, when dry
- Fulminates such as mercury fulminate
- Hydrogen peroxide becomes increasingly treacherous as the concentration rises above 30%, forming explosive mixtures with organic materials and decomposing violently in the presence of traces of transition metals
- N-Halogen compounds such as difluoroamino compounds and halogen azides
- N-Nitro compounds such as N-nitromethylamine, nitrourea, nitroguanidine and nitric amide
- Oxosalts of nitrogenous bases: perchlorates, dichromates, nitrates, iodates, chlorites, chlorates, and permanganates of ammonia, hydroxylamine, guanidine, etc.
- Perchlorate salts. Most metal, nonmetal and amine perchlorates can be detonated and may undergo violent reaction in contact with combustible materials
- Peroxides and hydroperoxides, organic
- Peroxides (solid) that crystallize from or are left from evaporation of peroxidizable solvents
- Peroxides, transition-metal salts
- Picrates, especially salts of transition and heavy metal, such as nickel, lead, mercury, copper and zinc
- Polynitroalkyl compounds such as tetranitromethane and dinitroacetonitrile
- Polynitroaromatic compounds, especially polynitro hydrocarbons, phenols and amines (e.g., dinitrotoluene, trinitrotoluene and picric acid)

Sensitizers and/or Allergens

Sensitizers and/or allergenic chemicals include a wide variety of substances that can produce skin and lung hypersensitivity. Common examples include nickel, chromates, formaldehyde, isocyanates and certain phenols. Once a person is sensitized, repeated exposures to even the smallest levels of sensitizers can result in life-threatening allergic reactions.

A sensitizer causes a substantial portion of people to develop an allergic reaction in normal tissue after repeated exposure to it. The reaction may be as mild as a rash (contact dermatitis) or as serious as anaphylactic shock.

Examples include:

Epoxides
Poison ivy
Chlorinated hydrocarbons
Formaldehyde
Nickel compounds
Toluene diisocyanate
Chromium compounds
Amines

Acutely Toxic Chemicals

Highly or acutely toxic chemicals are those that have been found through testing of laboratory animals to cause death when exposed at certain levels. This list is provided as a guide and is not all inclusive. Material Safety Data Sheets must be reviewed prior to using any chemical in the laboratory.

Acrolein
Acrylyl chloride
2-Aminopyridine
Benzyl chloride
Bromine
Carbon Monoxide
Chlorine dioxide
Chlorine trifluoride
Chlorpicrin
Cyanogen chloride
Cyanuric fluoride
Decaborane
Dichloro acetylene
Dimethyl disulfide
Dimethylsulfate
Dimethylsulfide
Ethylene chlorohydrin
Ethylene fluorohydrin
Hexamethylene diisocyanate
Hexamethyl phosphoramide
Iodine
Iron pentacarbonyl
Isopropyl formate
Methacryloyl chloride
Methacryloxyethyl isocyanate
Methyl acrylonitrile
Methyl chloroformate
Methylene biphenyl isocyanate
Methyl fluoroacetate
Methyl fluorosulfate
Methyl hydrazine
Methyl mercury (and other organic forms)
Methyltrichlorosilane
Methyl vinyl ketone
Nickel carbonyl
Nitrogen tetroxide
Nitrogen trioxide
Organo tin compounds
Osmium tetroxide
Oxygen difluoride
Ozone
Pentaborane
Perchloromethyl mercaptan
Phosphorus oxychloride

Phosphous trichloride
Sarin
Sulfur monochloride
Sulfur pentafluoride
Sulfuryl chloride
Tellurium hexafluoride
Tetramethyl succinonitrile
Tetranitromethane
Thionyl chloride
Toluene-2, 4-diisocyanate
Trichloro (chlormethyl) silane

Appendix D

LABORATORY-SPECIFIC CHEMICAL HYGIENE PLAN

The OSHA Laboratory Standard 29 CFR 1910.1450 requires written laboratory Chemical Hygiene Plans. The person responsible for the laboratory (i.e., Principal Investigator, Director, Supervisor, or Lab Manager) may follow the ASU EH&S CHP or may complete or assign someone to complete the following tasks for their laboratory for completing a laboratory specific CHP. The following checklist provides further guidance for completing each task and creating a laboratory-specific Chemical Hygiene Plan. For additional assistance, contact ASU EH&S, 480-965-1823.

□ **RESPONSIBLITY FOR LABORATORY-SPECIFIC CHEMICAL HYGIENE AND SAFETY**

Identify responsible persons and rooms covered by the plan. There must be at least one plan for each laboratory room (if procedures are uniquely different). Principal Investigators with multiple laboratories may wish to develop more than one laboratory-specific Chemical Hygiene Plan. In any case, the plan must be accessible to all laboratory staff at any time. The laboratory-specific plans must show evidence of review at least annually and should be updated as necessary.

□ **LABORATORY SAFETY TRAINING**

Each laboratory must conduct initial lab-specific training on lab safety policies and procedures for new lab employees. The EH&S Training Determination Table provides the instructions and schedules for the required safety training for laboratory employees. This table is available via the EH&S website. Training for all lab employees must be documented and show evidence of review at least annually.

□ **RESPONSIBLE PARTY INFORMATION SHEET (RPI)**

A Responsible Party Information sheet and a chemical inventory must be completed and updated annually by each Lab Principal Investigator, Lab Manager or designee. The RPI form and instructions are available on the EH&S web site.

□ **CHEMICAL INVENTORY**

An annual chemical inventory for each laboratory must be submitted to EH&S. The inventory must contain chemicals and compressed gas cylinders used or stored in the laboratory. The inventory requires the following items:

- An alphabetized list of the complete International Union of Pure and Applied Chemistry (IUPAC) names or acceptable trade chemical names for each chemical (abbreviations are unacceptable)
- Chemical Abstracts Service (CAS) #
- Quantity stored
- Storage or use location
- National Fire Protection Association (NFPA) Hazard Ratings.

Optional items in this inventory are normality or concentration and an indication if the MSDS is available in the laboratory. A chemical inventory template is available via ASU EH&S.

Unused or unwanted chemicals should be submitted for disposal in accordance with the ASU Hazardous Waste Management

□ **MATERIAL SAFETY DATA SHEETS (MSDS)**
Describe how and where MSDS and other references are available for laboratory employees. See the ASU CHP and ASU EH&S website for recommendations.

□ **LABORATORY REGISTRATION**
EH&S maintains the ASU laboratory safety registration program. Each laboratory will receive a laboratory registration upon completion and delivery of an updated chemical inventory and RPI to ASU EH&S. This registration must be updated annually.

□ **SITE-SPECIFIC INFORMATION ON CHEMICAL RECEIVING, STORING, AND DISPENSING**
If applicable, give the location of your laboratory's chemical receiving, storage, dispensing, and disposal area. Describe any ordering policies, procedures for hazardous chemicals, and hazardous waste. List any chemicals that require prior approval by the Principal Investigator prior to purchase.

□ **EMERGENCY RESPONSE**
Emergency response information and instructions are available via the ASU Emergency Response Guide. This guide must be posted in each laboratory. This guide is available via ASU EH&S and the EH&S website.

□ **LAB-SPECIFIC HAZARDOUS MATERIALS CONTROL SYSTEMS (ENGINEERING CONTROLS)**
List special systems intended to contain and/or manage hazardous materials. Most laboratories have chemical fume hoods, biological safety cabinets, glove boxes, flammable liquid storage cabinets, and/or special ventilation systems for specific equipment or operations. Include information on restrictions, special precautions or procedures, preventative maintenance schedules, and any other information relevant to safe operation of this equipment in the laboratory. Chemical fume hoods are performance evaluated annually by ASU EH&S. Contact ASU Facilities Management for evaluation of other exhaust systems. For additional information on laboratory safety equipment, contact ASU EH&S.

□ **PERSONAL PROTECTIVE EQUIPMENT (PPE)**
List all PPE available in the laboratory. Discuss specific uses, if appropriate. An ASU PPE Hazard Assessment form is available at the EH&S website.

□ **STANDARD OPERATING PROCEDURES**
Some laboratory procedures involving hazardous chemicals should have specific Standard Operating Procedures to address health and safety issues.

□ **OSHA REGULATED CARCINOGENS AND SUBSTANCES**

OSHA has specific mandates for several substances that may pose serious health risks to employees. ASU has established written plans and monitoring programs for those specific substances that are used in the laboratories. Each laboratory using any of these substances should contact ASU EH&S to enroll in the chemical-specific monitoring programs. Refer to the ASU CHP or contact ASU EH&S for details.

Appendix E

HAZARDOUS MATERIAL STORAGE GUIDE

ARIZONA STATE UNIVERSITY

HAZARDOUS MATERIAL STORAGE GUIDE

General Rules and Principles

Stock containers of chemicals ASU labs must be organized and stored in accordance with this guidance. The primary purpose of this guide is to provide hazardous material users guidance regarding how to control health or physical hazards posed by hazardous materials during storage in the lab. Specifically, it is designed to 1) protect flammables from ignition; 2) minimize the potential of exposure to poisons; and 3) segregate incompatible materials to prevent their accidental mixing.

A Designated Storage Place for Each Compound

Stock chemical containers should have a designated storage place and returned to that location after each use. Storage locations can be marked on containers.

Do not store excess supplies of chemicals on lab bench tops where they are unprotected from ignition sources or potentially damaged. Only chemicals in use or of low hazard (e.g., salts and buffers) are permitted on bench tops.

Do Not Store In Chemical Fume Hood

Do not keep excessive supplies of chemicals or waste in chemical fume hoods where they clutter space, interfere with the hood's air-flow, and contribute to materials that could become involved in a fire or accidental release of hazardous materials.

Close or Seal All Chemical Containers

All chemical containers must be closed except when adding or removing material including bottles used for hazardous waste chemicals. Hazardous waste containers must remain closed except when actually filling the container.

Alphabetical Only Within Storage Groups

Do not store chemicals in alphabetical order except within a storage group. Alphabetical arrangement of randomly collected chemicals often increases the likelihood of dangerous reactions by bringing incompatible materials into close proximity.

Away From Sun and Heat

Storage areas should not be exposed to extremes of heat or sunlight.

Not Under the Sink

Do not store any chemicals except compatible general cleaning agents under the sink.

Label Chemicals and Hazardous Waste Properly

All containers within the lab must be labeled according to the instructions in the ASU Chemical Hygiene Plan. Suspect and known carcinogens must be labeled as such and segregated within secondary trays to contain leaks and spills. Hazardous waste containers must be labeled with the words "Hazardous Waste" and must include a description of the contents.

Liquid Chemicals

Storage of liquid chemicals is more hazardous than storage of solids and are subject to numerous and varied storage requirements.

Safeguard Against Theft

This plan does not require security measures (e.g., locked cabinets) to prevent theft, but lab workers should make sure that lab doors are locked when unattended.

Chemical Storage Groups

Chemicals must be stored in the groups and corresponding facilities described on the following pages. This guide demonstrates nine storage groups. Seven of these groups are for storage of liquids because of the variety of hazards posed by these chemicals. Specific instructions must be followed for metal hydrides (Group 8) and certain individual compounds, but otherwise, all dry solids are in Group 9.

How to Determine Correct Storage Group

Determine the correct storage group by the hazard information on the chemical container label, chemical Material Safety Data Sheet, or contact ASU EH&S.

Multi-Hazard Liquids

Many liquid chemicals pose hazards that correspond to more than one storage group. Liquid storage groups are shown in descending order of hazard. The correct storage group for a multi-hazard chemical is the group representing the greatest storage hazard, or the group appearing highest in this list.

Group 1: Flammables — Most Hazardous

Group 2: Volatile Poisons

Group 3: Oxidizing Acids

Group 4: Organic and Mineral Acids

Group 5: Liquid Bases

Group 6: Liquid Oxidizers

Group 7: Non-Volatile Poisons

Group 8: Metal Hydrides

Group 9: Dry Solids Least Hazardous

Storage Group Definitions

Group 1: Flammable Liquids

Includes liquids with flashpoints < 100°F Examples: all alcohols, acetone, acetaldehyde, acetonitrile, amyl acetate, benzene, cyclohexane, dimethyldichlorosilane, dioxane, ether, ethyl acetate, histoclad, hexane, hydrazine, methyl butane, picolene, piperidine, propanol, pyridine, some scintillation liquids, all silanes, tetrahydrofuran, toluene, triethylamine, and xylene

Primary Storage Concern: To protect from ignition.

Acceptable Storage Facilities/Methods:

- Flammable cabinet
- Explosion-proof refrigerator/freezer

Compatible Storage Groups: Flammables may be with either Group 2 Volatile Poisons or Group 5 Liquid Bases, but not with both.

Group 2: Volatile Poisons

Includes poisons, toxics, and "select" and suspected carcinogens with strong odor or an evaporation rate greater than 1 (butyl acetate = 1). Examples: carbon tetrachloride, chloroform, dimethylformamide, dimethyl sulfate, formamide, formaldehyde, halothane, mercaptoethanol, methylene chloride, phenol

Primary Storage Concern: To prevent inhalation exposures.

Acceptable Storage Facilities/Methods:

- Flammable cabinet
- Refrigerator for containers less than 1 liter

Compatible Storage Groups: Volatile poisons may be stored with flammables if bases are not present.

Group 3: Oxidizing Acids

All oxidizing acids are highly reactive with most substances and each other. Examples: nitric, sulfuric, perchloric, phosphoric, and chromic acids.

Primary Storage Concern: Preventing contact and reaction with each other and other substances and corrosive action on surfaces.

Acceptable Storage Facilities/Methods:

- Safety cabinet
- Each oxidizing acid must be double-contained (i.e., the primary container must be kept inside a canister, tray or tub)

Compatible Storage Groups: Oxidizing acids must be double-contained and should be segregated in their own compartment in a safety cabinet. When quantities are small (e.g., 1 or 2 small bottles) they do not warrant a separate compartment. Small quantities may be double-contained and stored with Group 4 Organic and Mineral Acids. Store oxidizing acids on the bottom shelf, below Group 4.

Group 4: Organic and Mineral Acids

Organic and mineral acids. Examples: acetic, butyric, formic, glacial acetic, hydrochloric, isobutyric, mercaptoproprionic, proprionic, trifluoroacetic acids.

Primary Storage Concern: To prevent contact and reaction with bases and oxidizing acids and corrosive action on surfaces.

Acceptable Storage Facilities/Methods:

- Safety cabinet

Compatible Storage Groups: Small amounts of double-contained oxidizing acids can be stored in the same compartment with organic acids if the oxidizing acids are stored on the bottom shelf.

Exceptions: Acetic anhydride and trichloroacetic anhydride are corrosive. These acids are very reactive with other acids and should not be stored in this group. It is better to store these with organic compounds.

Group 5: Liquid Bases

Liquid bases. Examples: sodium hydroxide, ammonium hydroxide, calcium hydroxide, glutaraldehyde

Primary Storage Concern: Preventing contact and reaction with acids.

Acceptable Storage Facilities/Methods:

- Safety cabinet
- In tubs or trays in a standard cabinet

Compatible Storage Groups: Liquid bases may be stored with flammables in the flammable cabinet if volatile poisons are not stored in the same cabinet.

Group 6: Liquid Oxidizers

Oxidizing liquids react with everything potentially causing explosions or corrosion of surfaces. Examples: ammonium persulfate, hydrogen peroxide (if greater than or equal to 30%)

Primary Storage Concern: To isolate from other materials.

Acceptable Storage Facilities/Methods:

- Total quantities exceeding 3 liters must be kept in a cabinet housing no other chemicals
- Smaller quantities must be double-contained when stored near other chemicals (e.g., in a refrigerator)

Compatible Storage Groups: None

Group 7: Non-Volatile Liquid Poisons

Includes highly toxic (LD_{50} oral rat < 50 mg/kg) and toxic chemicals (LD_{50} oral rat < 500 mg/kg), "select carcinogens", suspected carcinogens, and mutagens. Examples: acrylamide solutions; Coomassie blue stain; diethylpyrocarbonate; diisopropyl fluorophosphate; uncured epoxy resins; ethidium bromide; triethanolamine

Primary Storage Concern: To prevent contact and reaction with other substances.

Acceptable Storage Facilities/Methods:

- Cabinet or refrigerator (i.e., must be enclosed)
- Do not store on open shelves in the lab or cold room

- Liquid poisons in containers larger than 1 liter must be stored below bench level on shelves closest to the floor; smaller containers of liquid poison can be stored above bench level only if behind sliding (non-swinging) doors.

Compatible Storage Groups: Non-hazardous liquids (e.g., buffer solutions).

Exceptions: Anhydrides (e.g., acetic and trichloroacetic) are organic acids, however it is better to store them with this group since they are highly reactive with other acids.

Group 8: Metal Hydrides

Most metal hydrides react violently with water; some ignite spontaneously in air (pyrophoric). Examples: sodium borohydride, calcium hydride, lithium aluminum hydride

Primary Storage Concern: To prevent contact and reaction with liquids and, in some cases, air.

Acceptable Storage Facilities/Methods:

- Secure, waterproof double-containment according to label instructions
- Isolation from other storage groups

Compatible Storage Groups: If securely double-contained to prevent contact with water and/or air, metal hydrides may be stored in the same area as Group 9 Dry Solids.

Group 9: Dry Solids

Includes all powders, hazardous and non-hazardous. Examples: benzidine, cyanogen bromide, ethylmaleimide, oxalic acid, potassium cyanide, sodium cyanide

Primary Storage Concern: To prevent contact and potential reaction with liquids.

Acceptable Storage Facilities/Methods:

- Cabinets are recommended, but if not available, open shelves are acceptable
- Store above liquids
- Warning labels on highly toxic powders should be inspected and highlighted or amended to stand out against less toxic substances in this group
- It is recommended that the most hazardous substances in this group be segregated
- It is particularly important to keep liquid poisons below cyanide- or sulfide-containing poisons (solids); a spill of aqueous liquid onto cyanide- or sulfide-containing poisons would cause a reaction that would release poisonous gas

Compatible Storage Groups: Metal hydrides, if properly double-contained may be stored in the same area.

Exceptions: Solid picric or picric sulfonic acid can be stored with this group, but should be checked regularly for dryness. When completely dry, picric acid is explosive and may detonate upon shock or friction.

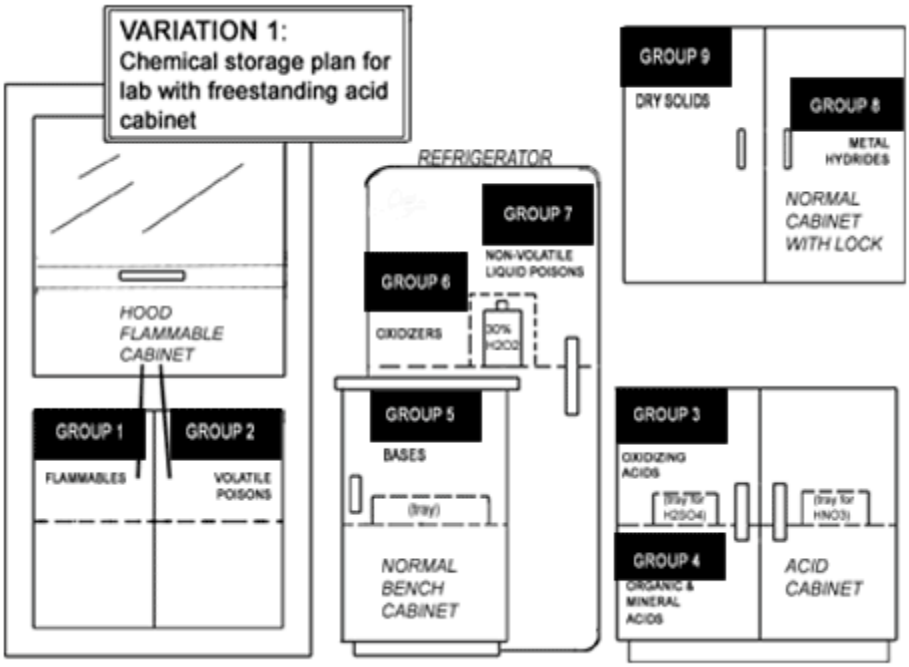
Storage Plan Variations for Different Lab Facilities

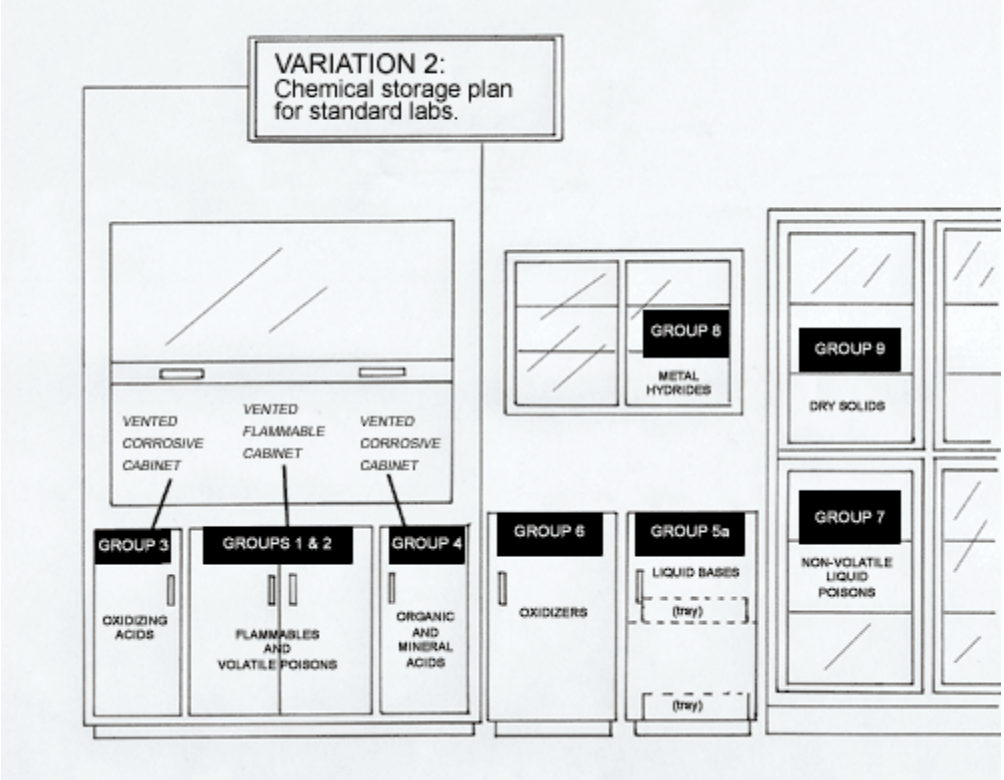
On the following pages are illustrations of possible (non mandatory) chemical storage arrangements for two types of lab facilities. They are provided merely as examples of arrangements that satisfy the requirements of the chemical storage plan. They are not intended to restrict storage to the particular arrangements and facilities depicted. Refer to Storage Group Definitions for segregation and facility requirements.

The illustrations are titled as follows:

Variation 1: Chemical storage plan for lab with freestanding acid cabinet.

Variation 2: Chemical storage plan for standard labs.




VARIATION 2:
Chemical storage plan
for standard labs.
VENTED
CORROSIVE
CABINET
VENTED
FLAMMABLE
CABINET
VENTED
CORROSIVE
CABINET
GROUP 3
OXIDIZING
ACIDS
GROUPS 1 & 2
FLAMMABLES
AND
VOLATILE POISONS
GROUP 4
ORGANIC
AND
MINERAL
ACIDS
GROUP 8
METAL
HYDRIDES
GROUP 6
OXIDIZERS
GROUP 5a
LIQUID BASES
(tray)
(tray)
GROUP 9
DRY SOLIDS
GROUP 7
NON-VOLATILE
LIQUID
POISONS

Examples of Incompatible Chemicals

The following list is not a complete listing of incompatible materials. It contains some of the more common incompatible materials. Always research materials such as Material Safety Data Sheets you work with in order to work safely in the lab.

Chemicals listed in Column A should not be stored with or used near those in Column B.

Column A	Column B
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetic anhydride	Hydroxyl-containing compounds such as ethylene glycol, perchloric acid
Acetone	Concentrated nitric and sulfuric acid mixtures, hydrogen peroxide
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali and alkaline earth metals such as powdered magnesium, sodium, potassium	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury, halogens, calcium hypochlorite, hydrofluoric acid
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids, heavy metals and their salts, oxidizing agents
Calcium oxide	Water
Carbon, activated	All oxidizing agents, calcium hypochlorite
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible material
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Chromic acid and chromium trioxide	Acetic acid, alcohol, camphor, glycerol, naphthalene, flammable liquids in general
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, other oxidizing agents
Fluorine	All other chemicals
Hydrides	Water
Hydrocarbons (e.g., butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, peroxides
Hydrocyanic acid	Nitric acid, alkalis
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, any flammable liquid (i.e., alcohols, acetone), combustible materials, aniline, nitromethane
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Metal hydrides	Acids, water
Nitrates	Acids
Nitric acid (concentrated)	Acetic acid, acetone, alcohol, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Mercury and silver and their salts
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, or gases
Perchloric acid	Acetic anhydride, alcohol, bismuth, paper, wood, grease, oils
Permanganates	Concentrated sulfuric acid, glycerol, ethylene glycol, benzaldehyde
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold

Phosphorus, white	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids, ammonium salts, metal powders, sulfur, finely divided organics, combustibles
Potassium perchlorate (see also chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Silver and silver salts	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, other chlorinated hydrocarbons, water
Sodium nitrate	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	Chlorates, perchlorates, permanganates

Adapted from *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*, National Research Council, 1995

Basic Chemical Segregation

Hazard Class of Chemical	Recommended Storage Method	Examples	Incompatibilities
Compressed gases - Flammable	Store in a cool, dry area, away from oxidizing gases. Securely strap or chain cylinders to a wall or bench.	Methane Hydrogen Acetylene Propane	Oxidizing and toxic compressed gases, oxidizing solids.
Compressed gases - Oxidizing	Store in a cool, dry area, away from flammable gases and liquids. Securely strap or chain cylinders to a wall or bench.	Oxygen Chlorine Bromine	Flammable gases
Compressed gases - Poisonous	Store in a cool, dry area, away from flammable gases and liquids. Securely strap or chain cylinders to a wall or bench.	Carbon monoxide Hydrogen sulfide Nitrogen dioxide	Flammable and/or oxidizing gases.
Corrosives - Acids	Store separately in acid storage cabinet. Segregate oxidizing acids (i.e., Chromic, nitric, sulfuric, and perchloric acids) from organic acids	Acetic acid Phenol Sulfuric acid Chromerge Nitric acid Perchloric acid Chromic acid Hydrochloric acid	Flammable liquids, flammable solids, bases, oxidizers
Corrosives - Bases	Store in separate corrosive storage cabinet. Store solutions of inorganic hydroxides in labeled polyethylene containers.	Ammonium hydroxide Sodium hydroxide Calcium hydroxide	Flammable liquids, oxidizers, poisons, and acids
Flammable Liquids	Store in flammable storage cabinet and away from sources of ignition. Store highly volatile flammable liquids in an explosion-proof refrigerator.	Acetone Benzene Diethyl ether Methanol Ethanol Toluene Glacial acetic acid	Acids, bases, oxidizers, and poisons

Flammable Solids	Store in a separate dry, cool area away from oxidizers, corrosives, flammable liquids	Phosphorus, yellow Calcium carbide Picric acid Benzoyl peroxide	Acids, bases, oxidizers, and poisons
General Chemicals - Non-reactive	Store on general laboratory benches or shelving preferably behind glass doors and below eye level.	Agar Sodium chloride Sodium bicarbonate Most non-reactive salts	See specific MSDS.
Oxidizers	Store in a spill tray inside a chemical storage cabinet. Separate from flammable and combustible materials.	Ammonium persulfate Ferric chloride Iodine Sodium hypochlorite Benzoyl peroxide Potassium permanganate Potassium dichromate The following are generally considered oxidizing substances: Peroxides, perchlorates, chlorates, nitrates, bromates, and superoxides.	Separate from reducing agents, flammables, and combustibles.
Poisons/Toxic Compounds	Store separately in vented, cool, dry area, in unbreakable chemically-resistant secondary containers and in accordance with the hazardous nature of the chemical.	Aniline Carbon tetrachloride Chloroform Cyanides Heavy metals compounds, i.e., cadmium, mercury, osmium Oxalic acid Phenol Formic acid	Flammable liquids, acids, bases, and oxidizers. See specific MSDS.

Water-Reactive Chemicals	Store in dry, cool location, protect from water fire sprinkler.	Sodium metal Potassium metal Lithium metal Lithium aluminum hydride	Separate from all aqueous solutions and oxidizers.
Carcinogens	Label all containers as "Cancer Suspect Agents". Store according to the hazardous nature of the chemical, using appropriate security when necessary.	Benzidine Beta-naphthylamine Benzene Methylene chloride Beta-propiolactone	See specific MSDS.
Teratogens	Label all containers as "Suspect Reproductive Hazard". Store according to the hazardous nature of the chemical, using appropriate security when necessary.	Lead and mercury compounds Benzene Aniline	See specific MSDS.
Peroxide-Forming Chemicals	Store in air-tight containers in a dark, cool, dry area. See Table 3 for recommended storage time limits.	Diethyl ether Acetaldehyde Acrylonitrile	See specific MSDS.
Strong Reducing Agents	Store in cool, dry, well-ventilated location. Water reactive. Segregate from all other chemicals.	Acetyl chloride Thionyl chloride Maleic anhydride Ferrous sulfide	See specific MSDS.

Suggested Storage Time Limits for Common Peroxide Crystal Forming Compounds

Peroxide formation occurs when certain laboratory chemicals react with air at ordinary temperatures to form peroxy compounds, which are violently reactive or explosive. Organic peroxides are classified as low-power explosives that are hazardous because of the sensitivity to shock, sparks or other ignition sources. Additionally they are sensitive to heat, friction, impact, light and strong oxidizing and reducing agents. All organic peroxides are flammable and have a specific rate of decomposition under a given set of conditions. Due to unusual stability problems, bulk quantities of peroxides should be approached with caution because they may generate enough heat to auto accelerate up to ignition. Peroxides/Peroxide forming chemicals include, but are not limited to the following lists.

MOST DANGEROUS: Discard after 3 months. Peroxide formation hazard during storage.	
Diisopropyl ether	Potassium metal
Divinyl acetylene	Sodium amide
Isopropyl ether	Vinylidene chloride

DANGEROUS: Discard after one year. Peroxide formation hazard during storage and on concentration (i.e., distillation) of compound.		
Acetal	Dicyclopentadiene	Methyl cyclopentane
Acetaldehyde	Diethyl ether	Methyl isobutyl ketone
Cumene	1,4-Dioxane	Tetrahydrofuran
Cyclohexene	Ethylene glycol dimethyl ether	Tetrahydronaphthalene
Diacetylene	Methyl acetylene	Vinyl ethers

DANGEROUS: Discard after one year. Peroxide formation causes initiation of hazardous polymerization.		
Acrylic acid	Chloroprene	Tetrafluoroethylene
Acrylonitrile	Chlorotrifluoroethylene	Vinyl acetate
1,3-Butadiene	Methyl methacrylate	Vinyl acetylene
2-Butanol	2-Propanol	Vinyl chloride
	Styrene	Vinyl pyridine