Risk Management & Safety

Chemical Hygiene Plan

(The OSHA Laboratory Standard)

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I. Introduction

Executive Summary

The University of Nevada Las Vegas (UNLV) is committed to establishing and maintaining a safe and healthful work environment for all faculty, staff, and students and to preventing adverse environmental effects on the surrounding community. To this end, the University has developed this comprehensive chemical hygiene plan. This document is designed to delineate policy for the safe usage, storage, transport and disposal of chemicals at UNLV. This plan describes the best practices, precautions and necessary equipment and facilities to meet this end. It also assures compliance with 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories"

Additionally, all researchers must develop laboratory specific training, practices and procedures for the specific experiments being conducted. Investigators are encouraged to insert written documentation of these lab specific activities into this manual. Finally, laboratory faculty and staff are encouraged to have open discussions with the UNLV campus Chemical Hygiene Officer, especially when planning new experiments. This will serve the dual purpose of assuring regulatory compliance and ensuring appropriate specific precautions are utilized.

Finally, it is the intent of UNLV that this manual be viewed as a living document that can be amended as appropriate to continually improve the procedures needed for the safe use of chemicals at UNLV.

Ultimately, worker safety and equipment maintenance in any laboratory is the responsibility of the lab manager, supervisor and anyone working, using equipment or space on UNLV property.

A. Explanation of the Laboratory Standard

On January 31, 1990, the Occupational Safety and Health Administration (OSHA) issued a safety and health standard entitled "Occupational Exposure to Hazardous Chemicals in Laboratories" (29CFR 1910.1450). The basis for this standard was a determination by OSHA that laboratories are different from industry with respect to the usage and handling of hazardous chemicals. Thus, OSHA issued this standard because industry consensus was that an approach different from OSHA's substance specific health standards was warranted to protect laboratory workers. The standard became effective in May 1990 and a compliance date of January 31, 1991 was set.

The purpose of the standard and this manual is to ensure that the hazards of all chemicals handled and used in labs are evaluated, addressed, and conveyed to faculty, staff, and students.

This manual serves as the UNLV Chemical Hygiene Plan. It is designed for alerting laboratory workers to potential workplace hazards and for providing guidance to employees for avoidance of exposure to chemicals through their adherence to safe work practices and procedures. For questions on definitions in this plan, contact the UNLV Chemical Hygiene Safety Officer.

It supersedes the plan published in the University of Nevada Las Vegas and Community College of Southern Nevada Hazardous Materials Management Program XVI which became effective 6/28/90 and all previous versions of the UNLV Chemical Hygiene Plan.

B. Applicability of the Laboratory Standard

The Laboratory Standard applies to all UNLV Departments engaged in the use of hazardous chemicals in laboratories where:

1. Chemical operations are carried out on a laboratory scale as opposed to operations whose objective is to produce commercial quantities of materials.
2. Operations are designed to be easily and safely operated by one person.
3. Multiple chemicals or multiple processes are used.
4. Procedures involved are not part of a product process nor simulate production process.
5. Standard laboratory procedures and equipment are commonly used to minimize potential employee exposure.
   <u>Exceptions:</u>
6. For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply, unless that particular standard states otherwise or unless conditions listed immediately below apply.
7. Where the Action Level or Permissible Exposure Limit is routinely exceeded for an OSHA regulated substance that has exposure monitoring and medical surveillance requirements, monitoring shall be conducted in accordance with "Employee Exposure Determination" below and medical surveillance requirements shall be in accordance with the specific standard.
8. Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.
9. This standard shall not apply for laboratory uses of hazardous chemicals which provide no potential employee exposure such as:
   a. Procedures using chemically impregnated test media that would not release these chemicals during the normal working procedures.
   b. Commercially prepared kits in which all the reagents needed to conduct the test are contained in the kit.

C. Implementation of the Chemical Hygiene Plan

In order to provide an on-going program, this Chemical Hygiene Plan will be implemented at UNLV. Training will be provided in accordance with the training section below. For questions or concerns about the UNLV Chemical Hygiene Program contact the UNLV Chemical Hygiene Safety Officer.

D. Permissible Exposure Limits (PEL's) and Threshold Limit Values (TLV's) will be observed.

As established in OSHA tables 29 CFR 1910.1000.

E. Hazard Recognition

The initial recognition of a hazard is the primary responsibility of the worker and his/her supervisor. The Chemical Hygiene Safety Officer shall also note hazards as part of the hazard assessment evaluations. The following factors need to be evaluated in any specific exposure:

1. Toxicity of the material - the greater the toxicity, the smaller the amount that can cause harm.
2. Quantity - the effect on a worker is proportional to the quantity involved in an exposure.
3. Rate of release - will determine the magnitude of exposure.
4. Identifying odors.
5. Physical properties of the material.
6. Chemical reactivity.
7. Contact requiring first aid treatment.
8. Handling requiring protective clothing or storage in a vented or secure area.
9. Proper spill cleanup and disposal techniques.

F. Employee Exposure Determination

If the PEL/TLV is expected to be routinely exceeded for any given procedure, monitoring for the specified hazard will be conducted in accordance with the appropriate NIOSH Method. The monitoring frequency will correspond to that specified in the relevant standard for any substance regulated by an OSHA standard. The employee shall be notified of the results of the monitoring in writing within 15 days of the receipt of the monitoring results.

G. Elements of the Chemical Hygiene Plan

In the Chemical Hygiene Plan, laboratory workers will be made aware of:

1. Standard operating procedures to be followed to ensure safety and health when laboratory work involves the use of hazardous chemicals.
2. Control measures (engineering controls, personal protective equipment, and hygiene practices) to reduce employee exposure to hazardous substances.
3. Measures taken to insure proper performance protective equipment including fume hoods.
4. Available employee information and training.
5. Criteria for evaluating a particular laboratory procedure or activity prior to the implementation of the procedure.
6. Availability of medical examination and consultation when signs or symptoms of exposure to hazardous chemicals are developed, when exposure monitoring reveals an exposure routinely above the action level or PEL, or when a spill, leak, or other event occurs and results in the likelihood of a hazardous exposure.
7. Designated personnel responsible for implementing the Chemical Hygiene Plan, including the Chemical Hygiene Officer.

8. Steps taken to provide additional employee protection when working with particularly hazardous substances. These include establishing a designated work area, using containment devices such as fume hoods, procedures for safe removal of contaminated waste, and the use of decontamination procedures.

A copy of the OSHA Laboratory Standard can be obtained from your Chemical Hygiene Officer or www.osha.gov. It is readily available to employees, their representatives, and any representative of the Assistant Secretary of Labor for OSHA or the State of Nevada.

H. Responsibilities

1. Responsibility of Management (President, Vice Presidents, Provost, Deans, Departmental Chairs and Research Lab Directors)

    a. UNLV is committed to safety of all faculty, staff, and students. This policy affects not only the daily operations of individual laboratories, but also the overall construction and maintenance of the facility. **SUPERVISORS ARE ULTIMATELY RESPONSIBLE FOR THE SAFETY OF THEIR EMPLOYEES AND THEIR OWN SAFETY**. Specifically, supervisors and management must contribute by requiring the strict adherence to established standards, practices, and procedures. Proper maintenance of all safety and research equipment is included.
    b. In every laboratory, the principal investigator shall ensure that the provisions of the CHP are implemented and monitor the compliance of the personnel under their control.

2. Responsibility of the Chemical Hygiene Officer
    a. The Chemical Hygiene Officer (CHO) develops and updates the Chemical Hygiene Plan and appropriate policies and practices. The CHO also provides technical assistance in complying with The Chemical Hygiene Plan and answers any safety questions for employees. The CHO can assist project directors in developing appropriate safety precautions for new projects and procedures. In conjunction with other Risk Management & Safety staff the CHO monitors procurement of new chemicals and the collection and disposal of chemical wastes. The CHO remains current on evolving legal rules and regulations concerning chemicals used at UNLV.
    b. The Chemical Hygiene Officer provides employees compliance assistance with the Chemical Hygiene Plan. The CHO monitors proper functioning of control devices such as fume hoods and helps arrange for prompt repairs if needed. The CHO performs or oversees chemical hygiene and housekeeping inspections, including inspections of emergency equipment.
    c. The Chemical Hygiene Officer monitors manufacturer's Safety Data Sheets. The CHO determines when a complaint of possible overexposure is "reasonable" and should be referred for medical consultation. The CHO determines when an "Exposure Assessment" is appropriate and will

conduct these assessments. Finally, the CHO reviews chemical inventory to determine which chemicals are carcinogens or particularly hazardous substances.

3. Responsibilities of Employees
    a. Every employee is responsible for his/her own safety. It is the responsibility of employees to review this chemical hygiene plan and understand all portions. It is also the responsibility of employees to read and follow safety protocols and ask questions when they are unsure of the safety of a procedure. It is recognized that in many circumstances special technical assistance is required to properly evaluate issues of chemical hygiene, laboratory safety, and occupational health. Additional assistance, when needed, may be obtained by contacting the Chemical Hygiene Safety Officer or other Risk Management and Safety staff.
4. Responsibility Toward Outside Contractors and Maintenance Workers
    a. Management, the Chemical Hygiene Safety Officer, and the employees such as principle investigators, managers and lab personnel are all responsible for the safety of outsiders to the lab areas. Employees are responsible for the daily maintenance of their areas and maintenance workers would not be expected to be present in lab areas on a daily basis. Work by outside contractors or workers should be scheduled so that one or more responsible employees are present at all times. These outside people should be briefed on the operations taking place around them and should be provided with any required personal protective equipment. The scope of cleaning by maintenance workers should be limited to floors, windows, etc. and cleaning of counters and shelves should be conducted by laboratory employees. The presence of outsiders in the lab areas should be minimized as much as possible.
5. Age Requirements for Entering Laboratories
    a. Individuals under the age of 18 who are not UNLV students attending a laboratory class shall not be permitted to enter a laboratory at UNLV. Individuals under the age of 18, including UNLV students, shall not enter a laboratory that contains radioactive materials, explosive materials, components of explosive materials or materials that may explode under foreseeable or plausible conditions. Individuals under the age of 15 shall never enter a laboratory. Individuals aged 16 and 17 shall only enter a laboratory with signed parental permission after the laboratory has been shown to not contain any material that would limit entrance by individuals under the age of 18. Individuals under the age of 18 shall not be allowed to work or perform research activities in any laboratory at UNLV.

II. Standard Operating Procedures for Laboratory Chemicals

The goal of the standard operating procedures is to reduce worker exposure to potentially hazardous materials or situations. Adherence to standard operating procedures is the responsibility of the Principle Investigator or lab manager.

A. Administrative Procedures

1. Chemical Procurement

When a new substance that is known or suspected to be hazardous is received, information concerning its proper handling methods should be given to all those who will be using or exposed to it. The chemical container must be dated when received and when opened. Information on the proper handling, storage, and disposal shall be known to all involved personnel at the time of receipt of the chemical. Personnel who receive chemical shipments shall be trained as required by DOT and knowledgeable of the proper procedures for receipt. Chemical containers shall not be accepted without accompanying labels, Safety Data Sheets, and packaging in accordance with all appropriate regulations.

When a chemical is purchased outside the normal RMS receiving process, such as personally bringing the chemical on campus or, when a chemical is delivered directly to a laboratory / department bypassing UNLV central receiving. RMS must be notified immediately and an SDS submitted so it can be added to the CHIMERA Inventory. The researcher can also request their own personal login and password at: https://rms.unlv.edu/chimera/unlv/

This will allow them to view, edit and add chemicals to their own laboratory specific chemical inventory.

2. Prior Approval

Categories of materials with recognized health or safety hazard potentials, requiring notification to the Department of Risk Management & Safety and prior approval from the Principal Investigator in charge of the laboratory when purchased and/or used in the laboratory include:

a. Chemicals
b. Compressed gases
c. Pyrotechnic materials
d. Radioactive materials
e. Lasers
f. Biological materials handled at Biosafety Level 2 or above and biological toxins

In addition, the Chemical Hygiene Safety Officer (CHO) should review, if requested, the purchase of all PPE.

3. Policy for Working with Hazardous Materials

The following is a list of specific activities that must be exercised whenever hazardous materials are used by a UNLV employee or student.

Before working with any hazardous material the faculty or staff supervisor must conduct a planning activity during which the operating procedures are reviewed with lab personnel to ensure that the hazardous materials will be used properly and safely. Safety Data Sheets must be reviewed to identify the hazardous properties of the materials to be used. This planning activity will provide the opportunity to:

a. gather information to establish the appropriate process and safety equipment necessary for the procedure,
b. select the appropriate eye protection, and other personal protective equipment necessary for the safe use of the hazardous materials, and
c. determine if additional training is needed by the user(s) of the hazardous materials.

It is also necessary to prepare for the collection and storage of hazardous waste materials generated by the process. All containers and equipment needed must be made available and ready before working with the hazardous materials.

Whenever the proposed activities involve students or staff inexperienced in the activities, the responsible faculty or staff supervisor will provide or arrange for the required training to those students or staff for which he or she is responsible. This training must be documented with all students signing that they received and understood the training.

It is the responsibility of the faculty or staff supervisor to determine the degree of hazard and to arrange for the appropriate level of supervision and/or available assistance for themselves or those under their supervision, including undergraduate and graduate students and inexperienced staff.

If it is determined necessary, the faculty or staff supervisor will arrange to have periodic crosschecks by someone else in the building, or require a lab partner be present if the hazard associated with the procedures requires it.

This supervision policy will apply to all situations every time, regardless of the location of the work activity.

4. Working Alone - Unattended Operations

Risk Management & Safety does not recommend that anyone work alone after hours. We recommend that at least two people work together at night, especially if the work could be dangerous or involves hazardous materials. It is the responsibility of the Laboratory Director/Principal Investigator, manager, or supervisor to establish the level of authority required for approval of an activity where an employee is working alone and give that approval in writing.

Usually, an employee authorized by his/her supervisor may work alone if it is a low-risk laboratory operation where there is little potential for a serious injury-producing accident. Even in low risk situations, there must be a mechanism for assuring that the laboratory worker is not alone and injured (for example a call schedule). For

higher-risk laboratory operations a laboratory partner (buddy system) should be utilized with an outside person aware of the operations and hazards.

B. General Chemical Safety

1. General Principles for Working with All Chemicals

Awareness is the key to chemical safety for all laboratory operations. Awareness requires that adequate information be acquired before using any chemical. In addition to chemical properties, a user needs to know its physical properties such as volatility, flammability, corrosivity, thermal stability, etc. Other awareness items include:

a. The chemical's hazards, as determined from the MSDS, container label and other appropriate references.
b. Appropriate safeguards for using that chemical, including personal protective equipment.
c. Location and proper use of emergency equipment.
d. How and where to properly store the chemical when not in use.
e. The proper personal hygiene practices. The correct methods of transporting chemicals within the facility.
f. Appropriate procedures for emergencies, including evacuation routes, spill cleanup procedures and proper waste disposal.
g. Assurance that the least hazardous chemicals and procedures possible that will work for the protocol were selected.
h. The safest way to make material/product containment transfers so as to avoid worker exposure or spills.

2. Storage and Distribution

Proper storage and distribution procedures can eliminate the cause of many accidental employee exposures. Appropriate measures include:

a. All chemicals received shall immediately be moved to designated storage areas. Glass containers shall be placed in carrying containers or shipping containers during transportation.
b. The storage area shall be well-illuminated, with all storage of corrosive materials maintained below eye level.
c. Chemicals shall be segregated by hazard classification and compatibility in a well-identified area, with local exhaust ventilation. Refer to Appendix A, Safe Storage of Chemicals, for storage guidelines and compatibility/incompatibility charts.
d. Mineral acids shall be separated from flammable and combustible materials. Appropriate separations and quantity limits are defined by the fire code currently applicable to UNLV.
e. Acid-resistant tubs shall be placed under bottles of mineral acids.
f. Acid-sensitive materials such as cyanides and sulfides shall be separated from acids or protected from contact with acids. Ideally, toxic compounds should be kept separate and under lock and key.

g. Highly toxic chemicals or other chemicals whose containers have been opened shall be stored in unbreakable secondary containers.
h. The storage area should not be in a preparation or repackaging area.
i. Chemicals being stored shall always be under the control of a responsible individual.
j. When chemicals, especially liquids, are taken from the stockroom and transported they shall be placed in a container or bucket for safety.
k. Storage of chemicals at the lab bench or other work areas shall be limited to those amounts necessary for one operation or shift. The container size shall be the minimum suitable to perform the tasks.
l. The amounts of chemicals at the lab bench shall be as small as practical. Chemicals in the workplace shall not be exposed to sunlight or heat.
m. Stored chemicals shall be examined at least annually by the laboratory staff for replacement based on chemical deterioration and container integrity. The inspection shall determine whether any corrosion, deterioration, or damage has occurred to the storage facility as a result of leaking chemicals. Expiration dates shall be checked and expired chemicals that pose a risk due to age shall be disposed of. Appendix C lists some peroxide formers that fall into this category. For this group of chemicals, duration of time since opening shall also be noted, and chemicals shall be disposed of according to Appendix C, or other similar guide, which ever lists the shorter time period. This inspection should be documented in the laboratory safety notebook. Unneeded or outdated items shall be properly discarded by contacting Risk Management and Safety at 895-4226.
n. Annual inventories of chemicals shall be conducted by the Department of Risk Management & Safety. During this inventory, chemical containers that have corroded or otherwise deteriorated shall be recommended for disposal.

All liquid chemicals should be kept in secondary containment, such as a Rubbermaid type tub, capable of holding the volume of most of the bottles in the tub.

3. Personal Hygiene

Personal hygiene is an important factor in chemical hygiene. Practices include:

a. Wash with soap and water promptly if skin contact is made with any chemical, regardless of hazard.
b. Wear appropriate eye protection AT ALL TIMES.
c. Avoid inhalation of chemicals; do not "sniff" test chemicals.
d. Do not mouth pipette any liquid chemical.
e. Always wash hands well with soap and water before leaving the laboratory.
f. Change clothing as soon as possible after leaving laboratory facility and launder clothes often.
g. Do not eat, drink, smoke, handle contact lenses or apply makeup in chemical areas.
h. Do not bring food, beverage, or tobacco products into chemical storage or use areas.
i. Minimize exposure to suspect substances of no known specific hazard.
j. Assume any mixture will be more toxic than its most toxic component.

k. Assume that all substances of unknown toxicity are toxic.
l. When working with a substance which presents a particular hazard, follow safety measures specified in the Safety Data Sheet (SDS).

4. Housekeeping

Good housekeeping practices are vital in a laboratory setting. Poor housekeeping can lead to easily avoidable accidents. Some items that are considered good housekeeping include:

a. Access to emergency equipment, showers, eyewashes, and exits should never be blocked, not even by a temporarily parked chemical cart. All safety equipment should function properly.
b. All chemical containers must be labeled with the commonly recognized identity of the contents and the hazards these compounds present to users.
c. Keep all work areas, especially laboratory benches, clear of clutter.
d. Keep all aisles, hallways, and stairs clear of all chemicals.
e. All chemicals should be placed in their assigned storage areas at the end of each work day.
f. At the end of each work day, assure that all containers are labeled as to contents.
g. Wastes should be properly labeled and kept in their closed containers.
h. Promptly clean up all spills; properly containerize and dispose of the spilled chemical and cleanup materials.
i. All working surfaces and floors should be cleaned regularly.
j. No chemicals are to be stored in aisles or stairwells, on desks, floors or in hallways.

5. Signs and Labels

Prominent signs and labels of the following types should be posted:

a. Telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers.
b. Identity labels, showing contents of containers (including waste receptacles) and associated hazards.
c. Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits and areas where food and beverage consumption and storage are permitted.
d. Warnings at areas or equipment where special or unusual hazards exist.

6. Solvent Storage and Handling

Flammable liquids are those having flash points below 100º F and combustible liquids are those having flash points at or above 100º F but below 200º F. Moderate amounts (less than 5 gallons) may be stored in a typical laboratory. Larger quantities require a flammable liquid storage cabinet which is designed to provide physical and thermal protection in case of a laboratory fire. These cabinets are not intended for storage of highly toxic materials. As a general policy, chemical storage should be limited to the quantities needed for current research. Also, applicable fire and building codes specify

quantity limits. Contact Risk Management & Safety for further details of storage limits.

7. Glassware and Laboratory Equipment, including Equipment essential and specifically placed in the lab for safety.
    a. all laboratory equipment shall be used only for its intended purpose.
    b. all glassware will be handled and stored with care to minimize breakage; all broken glassware will be immediately disposed of in the broken glass container. Glassware contaminated with hazardous or toxic materials must be kept separate and discarded as hazardous waste.
    c. all glass apparatus under vacuum shall be shielded to contain chemicals and glass fragments should implosion occur.
    d. labels shall be attached to all chemical containers, identifying the contents and related hazards.
    e. waste receptacles shall be identified using a label with the words "waste" or "hazardous waste". All chemicals placed in waste receptacles must be listed and properly segregated. Labels are available from Risk Management & Safety.
    f. all laboratory equipment shall be inspected on a periodic basis and replaced or repaired as necessary.
    g. a log book shall be maintained for ultra-centrifuges with careful attention being paid to rotor maintenance.
8. Vacuum and Pressure Operations

The proper and safe procedures for the operation of vacuum and pressure equipment are essential in the laboratory. The pressure differential created when laboratory apparatus is used at pressures above or below that of the atmosphere creates several potential hazards. The hazards of high pressure systems arise largely from failures caused by leaks, pulsation, vibration, and over pressure. Pressure gauges should be checked and recalibrated on a regular basis.

9. Sinks and Refrigerators
    a. Sinks
        i. Must not be used as a method of discarding organic chemical solvents. Hazardous chemicals may not be discarded in the sink. Small amounts of some nonhazardous chemicals may be allowed for sink disposal, only if RMS has been consulted for approval. Acidic or basic solutions that have been properly neutralized and contain no other underlying hazardous constituents can also be poured down the sink, if approval has been received from Risk Management & Safety staff.
        ii. Must have a screen or appropriate cover over sink drain to prevent solid material from entering the drain.
        iii. Should have rubber or plastic mats in and alongside the sink to prevent breakage of glassware.
        iv. Water should be added periodically to infrequently used sinks to prevent desiccation of the drain trap and exposure to sewer gases.
    b. Refrigerators

i. Food must not be stored in any laboratory refrigerator.
ii. Laboratory refrigerators must have appropriate signage stating "laboratory use only, no food or drink".
iii. Stored chemicals and other materials must be tightly closed and properly labeled. Out of date chemicals should be disposed of.
iv. A regular defrosting schedule should be maintained.
v. Household-type refrigerators must not be used for flammable chemical storage. Refrigerators that have been modified by eliminating sources of open electrical contents inside the storage cabinet; including lights, thermostat, and butter bin are not recommended. These changes do not make a refrigerator explosion proof. An explosion proof refrigerator should be purchased for storage of flammable or unstable chemicals.

10. Compressed Gases

Compressed gases present a variety of potential physical and chemical hazards in their storage, delivery, and use. Gases may be classified as toxic, pyrophoric, flammable, irritant, corrosive, inert, and oxidizing. Large releases of inert gases may displace air and cause asphyxiation (this is most apt to occur in confined spaces). Some compressed gases may have more than one potential hazard; for example, chlorine gas is corrosive, toxic, and oxidizing. Physical hazards may involve a sudden release of pressure which results in major damage to the facility or serious personal injury. Personal injuries are usually caused by the improper handling of gas cylinders.

Gas cabinets are recommended for storage of flammable gases and are required for highly toxic and pyrophoric compressed gases. These cabinets are ventilated so that laboratory occupants are protected from any release of a harmful gas from the gas cylinder, regulator, or manifold. They also minimize the hazards from external or internal fires. Safety features of gas cabinets can include sprinkler heads and heat and/or toxic gas sensors within the cabinet.

When gas cabinets are not available each gas cylinder must be separately secured to the wall or a sturdy table with a chain or strap.

11. Cryogenic Liquids

Cryogenic fluids have extremely low temperatures and are used in the laboratory often. They consist of liquefied gases at their boiling points which are -238º F (-150 º C) or lower. Both the liquid and the "boil off" vapor can rapidly freeze human tissue and can cause many materials to become very brittle. Cryogens commonly found in laboratories include liquefied helium, hydrogen, oxygen, and nitrogen.

Cryogenic fluids should only be handled in well ventilated spaces. Oxygen monitoring may be required, depending on the fluid being used. Appropriate protective equipment for use of cryogenic fluids includes a rubber apron, face shield and long insulated gloves.

12. Laboratory Freeze Dryers (Lyophilizers)

A freeze dryer is an instrument designed to dehydrate a sample solution by sublimation and vacuum. Some safety concerns are as follows:

a. if a radiation source is used, proper personal protective equipment should be used. The equipment should be properly decontaminated and the ice should be disposed of as radioactive waste.
b. if infectious biological materials are lyophilized, the same considerations as for the radioactive materials should be addressed.
c. when flammable liquids or hazardous chemicals are freeze dried, appropriate safety measures should be incorporated, including maintaining proper ventilation at all times. This is especially true for units which utilize methanol as an integral fluid in the instrument. For these units, also avoid exterior ignition sources.
d. a freezing or cold trap should be used to protect the vacuum pump and the environment when solvents or corrosives are lyophilized. Units utilizing chlorofluorocarbons as refrigerants should be tested for leaks on a regular basis.
e. When preparing samples for lyophilization, consult the Safety Data Sheet for proper handling and personal protective equipment.

f. implosions - in order to avoid implosion, inspect glass vessels for cracks or scratches that are signs of weakness and may cause failure. Do not substitute regular laboratory glassware for vacuum use. Locate the unit out of the traffic flow and shield it with Plexiglas or polycarbonate curtains.
g. miscellaneous - Follow the manufacturer's instructions preparing samples, filling ampoules, loading the unit, and venting slowly at the end of the run. Plug unused ports during operation and empty the condensate trap regularly.

13. Autoclaves

Autoclaves are commonly used equipment in laboratories. Each autoclave has unique characteristics. Review and understand the owner's manual before using any autoclave for the first time and as needed thereafter. Contact the manufacturer to request on-site training, as needed. Ensure the owner's manual is readily available in case questions arise during operation.

Autoclaves operate at high temperatures and pressures. Primary hazards include:

- Steam burns resulting from contact with steam escaping autoclave
- Burns resulting from physical contact with the autoclave structure
- Burns resulting from handling of vessels of boiling liquids removed from the autoclave
- Explosive breakage of glass vessels during opening and unloading

When using an autoclave:

a. Before use, check inside the autoclave to assure it is empty & contains no broken glass
b. Load the autoclave as described in the owner's manual.
c. Loosen caps on liquid containers to prevent bottles from shattering during pressurization
d. Use secondary containment to catch spills (a tray with solid bottom & walls works well)
e. Ensure plastic materials are compatible with autoclaving before initial use in autoclave
f. Glassware should never be placed directly on the autoclave bottom
g. (instead use tray as secondary containment)
h. Assure door of autoclave is latched & appropriate cycle is selected prior to initiation of cycle
i. Use heat-resistant gloves when opening the autoclave door.
j. Wait 5 minutes after the pressure reaches zero for loads containing only dry glassware, and 10 minutes after the pressure reaches zero for autoclaved liquid loads before opening the autoclave door
k. Minimum personal protective equipment (PPE) when removing items from an autoclave are rubber aprons & heat resistant gloves. Rubber sleeve protectors should be used if heat resistant gloves do not extend up arm.
l. The load must cool prior to touching it with ungloved hands. Allow a minimum of 15 minutes for non-liquid loads and an hour for liquid loads.
m. Let others know the load is hot (use signage if leaving the load)
n. Do not autoclave items containing corrosives (e.g. acids, bases, phenol), solvents or volatiles (e.g. ethanol, methanol, chloroform) or radioactive materials.
o. All staff must be properly trained prior to initial operation of an autoclave and should work under the supervision of an experienced autoclave worker.
p. Most accidents involving autoclaves occur during opening and unloading. <u>Never open the autoclave before the pressure gauge reaches zero.</u> Stand so that the door shields your body when opening the autoclave. Also, remember that glassware may have cracked during autoclaving.

14. Disposal of Chemicals

To dispose of unwanted or waste chemicals, including gases:

a. each item must be individually tagged and must be identified for removal. If contents are unknown or only partially known, a chemical analysis will be required at department's or research project's expense.
b. insure that items are securely packaged. Plastic containers are preferred over metal cans, whenever possible.
c. Use the online waste pickup request on the Risk Management & Safety’s web page for chemical pickup.
d. unwanted lecture bottles must be returned to the supplier. It is best to establish this arrangement with the supplier before purchasing gases. Disposal costs for unwanted lecture bottles are extremely high and will be paid by department or research project.

e. your location may require segregation of halogenated and non-halogenated solvents. Various chemicals must not be indiscriminately mixed prior to disposal. Segregation of chemicals is of utmost importance. Please refer to Appendix A, Safe Storage of Chemicals, or call RMS for additional information.
f. triple rinse empty chemical containers and mark out the label prior to disposal. Special considerations must be made for P-Listed chemicals. Contact RMS for additional information.

If you relocate your laboratory, follow all laboratory check-out procedures (Appendix E).

Waste chemicals shall be removed only by Risk Management & Safety staff.

C. Special Chemical Safety

1. Corrosive Substances

Chemical corrosives attack human tissue and cause irritation, chemical burns, and in severe cases, tissue destruction. In case of skin or eye contact with corrosives, prompt treatment with a physiologically correct buffered saline is important. Safety showers and eye-wash fountains must be provided for this purpose and must be readily available to all laboratory occupants. After a thorough flushing (at least 15 minutes), obtain medical attention as soon as possible.

Nose, throat, and lung injury may be caused by inhaling corrosive gases, vapors, or aerosols. The irritant nature of airborne corrosives can provide a warning. Ingestion of corrosives is less likely to occur in a laboratory; but if it does, seek immediate medical attention.

Types of corrosives and examples of each are:

a. Acids: Inorganic, or mineral acids, include sulfuric, nitric, hydrochloric, phosphoric, and hydrofluoric. Concentrated solutions of hydrofluoric acid (HF) can penetrate the skin and soft tissue, causing destruction and intense pain. Concentrations of HF below 20% are more insidious and symptoms may be delayed for up to 24 hours. Prompt and prolonged washing with physiologically correct buffered saline solution is essential if there has been any skin contact. Calcium gluconate gel should be spread over the affected area. **Then get immediate medical attention.** Organic acids contain a carboxylic group, (-COOH) and are generally less acidic and corrosive than the mineral acids. Common organic acids include acetic, benzoic, citric, and oxalic.
b. Bases: Bases are alkaline substances that have a pH above 9 when dissolved in water. Contact with the skin causes a "slippery" or "soapy" feeling. Examples of common bases include ammonium hydroxide, calcium hydroxide, potassium hydroxide, sodium hydroxide, potassium carbonate, and sodium carbonate. The eye is especially susceptible to alkalis so splash goggles or face shields are recommended whenever there is a possibility of eye contact.

c. Halogens: The elemental halogens (bromine, chlorine, fluorine, and iodine) are all extremely corrosive, especially to the respiratory system. They are also capable of causing the deterioration of many materials of construction used for gaskets, piping, and tubing.
d. Organic Compounds: Many organic liquid compounds are combustible and can be as corrosive as inorganic acids and bases. Examples include: phenols, amines, and some unsaturated ketones. In addition, many organics can be absorbed through the intact skin and produce toxic effects.

Refer to pertinent Safety Data Sheets for specific information.

2. Oxidizers

Oxidizers are compounds (solid, liquid, gas) that evolve oxygen or are electron acceptors either at room temperature or upon slight heating. This group includes: peroxides, chlorates, perchlorates, nitrates, permanganates, and the elemental halogens. Oxidizers can react vigorously at ambient temperatures when they contact organic material or reducing substances.

3. Oxygen and Moisture Reducing Compounds

Many chemical compounds deteriorate when exposed to air. For most of these, oxidation only causes a decrease in purity. But for a few, extreme reactivity with oxygen leads to other effects. Another group of compounds reacts with atmospheric moisture and causes the release of toxic or flammable gases or vapors or the generation of enough heat to cause fires and explosions.

Examples:

- Dichlorosilane: Forms silicon dioxide and hydrogen chloride on contact with air. Will detonate spontaneously under some conditions.
- Phosphides: React with moisture to form highly toxic phosphine (TLV=0.03 ppm.).
- Potassium: Reacts with moisture to release hydrogen and with oxygen to cause ignition and explosion.
- Selenides: Moisture causes release of the extremely toxic hydrogen selenide (TLV=0.05ppm.).
- Sodium: Reacts with moisture to release hydrogen. The heat generated may cause a fire.

Handling and Storage Requirements:

a. These substances should only be handled in a glove box with an inert atmosphere or in special glassware (Schlenk techniques) to avoid the aforementioned effects during experimental work. Storage in special containers with a nitrogen atmosphere is often necessary. Potassium and sodium are usually stored under a non- volatile hydrocarbon liquid to exclude oxygen and moisture.

4. Pyrophoric Compounds

Pyrophorics are a special subgroup of air-sensitive compounds. These substances will ignite spontaneously when exposed to air. The handling requirements for pyrophorics are extremely restrictive.

Examples:

- Uncoated Aluminum (Esp. powder): Alkyls ignite spontaneously in air. Also react violently with water and with oxygenated and halogenated solvents.
- Bromotrifluoroethylene: Ignites spontaneously in air to form hydrogen bromide and hydrogen fluoride which are corrosive and toxic.
- Diborane: May ignite spontaneously in air and may detonate under some conditions. Extremely toxic vapor (TLV=0.1 ppm).
- Phosphine: Its ability to ignite spontaneously in air may depend on purity. Phosphine gas is highly toxic (TLV=0.3 ppm.)
- Silane: May detonate violently when released in air, but usually it only ignites.

Handling and Storage Requirements:

The use of any of these compounds requires a Process Hazard Review. In all cases, a flow restrictive orifice in the cylinder valve is a required precaution. Special piping and fittings are also necessary.

5. Peroxide-Forming Compounds

Some organic compounds are unusually susceptible to atmospheric oxidation. They require special storage and handling procedures to minimize the formation of peroxides that may create an explosion hazard. Once formed, peroxides are thermally unstable and may also be shock-sensitive.

The types of organic compounds that are most apt to form peroxides include:

- aldehydes and ketones
- ethers - especially those with primary or secondary alkyl groups
- allylic or benzylic structures vinyl and vinylidene compounds

Avoid distilling compounds that may produce peroxides. There are test procedures for detecting peroxide compounds and approved methods are available for destroying them once they have formed. For more information, refer to Appendix C, Peroxide Forming Compounds.

6. Explosive and Shock-Sensitive Compounds

Shock-sensitive and/or explosive compounds are a safety concern even for laboratory-scale quantities.

The first step in safe operations with such substances is recognition of the potential for damage and personal injury. If possible, substitute with less hazardous materials.

Examples:

- Azides – Lead Azides
- nitro- Compounds – trinitrotoluene (TNT)
- poly-Nitrates – nitroglycol and nitroglycerine
- perchlorates – perchloric acid and associating salts
- picrates – picric acid and associating salts
- peroxides - benzoyl peroxide or methyl ethyl ketone peroxide

Handling and Storage Requirements:

Read the SDS and other literature to learn about the potential problems and the proper procedures for working safely with these substances. Also, be aware of the potential for inadvertent formation of explosive compounds such as heavy metal perchlorates when using perchloric acid to oxidize organic matter in an analytical procedure. A key to safe operations with explosive or shock sensitive substances is to use very small quantities at any one time or place. Special facilities are essential for the safe use and storage of explosive or shock sensitive substances. These should include adequate barriers and mechanical devices that permit remote operation.

7. Laser Installations

Lasers produce non-ionizing radiation capable of causing eye injury. Lasers operating outside of the visible light region (ultraviolet or infra-red) are especially hazardous. Each laboratory location using laser devices should be assigned a Laser Safety Officer to assist with laser safety issues. Contact the Radiological Safety Officer (895-4226) with questions.

Laser dyes are complex fluorescent organic compounds. In solution with organic solvents, these dyes form a lasing medium. Toxicity information on commercially available laser dyes is not extensive. However, the current research has found a number of the dyes to be mutagenic and possibly carcinogenic.

Because the toxicological properties of most laser dyes have not been fully investigated, these compounds must be handled with care.

Many of the solvents used to prepare laser dye solutions are both flammable and toxic. Suggestions to avoid exposure during the preparation and use of dye solutions include:

a. Wear protective equipment to avoid skin contact.
b. Use a glove-box or an efficient hood.
c. Use care in the design and assembly of dye pumping systems.

Laboratory cleanliness and good personal hygiene will help to avoid accidental ingestion.

Contact the RMS Radiation Safety Officer regarding more specific information and a copy of the comprehensive and official copy UNLV Laser Safety Program.

III. Criteria for Implementation of Control Measures

Control methods may emphasize control of the contamination source, control of the work environment by engineering methods, or controls directed at the worker. Usually the effects of various control methods are additive. Thus, a combination of control techniques may be effective when no single method is adequate.

A. Direct Methods of Control

Substituting a less toxic substance is very effective in reducing chemical exposures. For example, an azeotropic mixture of toluene (32%) and ethanol (68%) is an effective solvent that approximates the volatility of benzene but is much less toxic. Sometimes water plus a detergent will be as effective as an organic solvent in cleaning applications.

B. Engineering Methods of Control

The following paragraphs describe specific devices and systems that are designed to prevent the exposure of workers to chemical substances.

1. Glove Boxes
    a. If chemicals can be totally isolated from the worker's environment, then exposure is reduced to zero. Glove boxes are the most common device to accomplish this. When used to control chemical exposures, the glove box should be operated below atmospheric pressure to prevent the escape of gases and vapors.

The glove material must be carefully selected to avoid deterioration or penetration by the chemicals in use.

For exploratory work or very occasional operations, transparent glove bags are useful. If these become contaminated, they should be discarded as chemical waste.

2. Chemical Fume Hoods

Chemical fume hoods are the primary means of preventing inhalation exposures in the laboratory. Each hood should be labeled with a QR Code, which when scanned with a smart phone or other electronic device to be connected to the RMS database. Enter the fume hood identifying number (barcode) to see the flow rate measured from the latest test. Face velocities should be between 80-150 linear feet per minute (lfm) for chemical usage and for radioactive materials usage. RMS will measure the flow in linear feet per minute once per calendar year. Be sure that all hoods are checked at the required intervals. Call the HELP Desk at 5-4357 if the hood is not functioning.

Fume hood performance can be enhanced in several ways:

- work as far inside the hood as possible.
- keep exhaust slots, especially the bottom rear opening, free of obstructions.
- use a monitoring device or strips of tissue paper to verify air flow.

- avoid disabling any alarms that indicate inadequate flow.

For more information on proper Chemical Fume Hood practices view the UNLV Chemical Fume Hood Guide on the Risk Management and Safety website.

3. Laminar Hoods

Laminar flow hoods are designed to provide a clean air stream for product cleanliness. Although some of these devices may be adjusted to provide some control of air contaminants, they are not suitable for work with chemicals that are toxic, biohazards or radioactive materials.

4. Local Exhaust Ventilation

Due to the size or configuration of some laboratory equipment, it may not be feasible to place it in a fume hood, even though it may be a source of air contamination. In such cases, a flexible exhaust duct (snorkel) may provide control. Snorkels are most useful where the contaminant releases are localized. Because their zone of control does not extend beyond two duct diameters and their capture velocity is reduced by 90% at one duct diameter, careful placement is necessary. The control zone may be extended by using baffles or partial enclosures.

5. General Ventilation

General ventilation controls air contaminants by diluting them to an acceptably low concentration. It is most useful where there are small scattered low toxicity contaminant sources in the laboratory. General ventilation is less useful where the laboratory worker is close to or directly involved with the source operation. The effectiveness of general ventilation can be enhanced by reducing the rate of contaminant release with enclosures (watch glass covers for solvent beakers are an example).

6. Scrubbers and Air Cleaners

Scrubbers and air cleaners are used to reduce the concentration of contaminants in exhaust air. Their main effect on indoor air quality is to prevent the recycling of contaminants by re-entry into air intakes.

IV. Personal Protection

Although proper design of the work environment and use of engineering methods are preferred for controlling chemical hazards in the laboratory, additional personal protection is generally recommended.

A. Respiratory Protection

Respirators are used to prevent inhalation of air contaminants such as dusts, fumes, mists, vapors, and gases. Positive pressure types can also supply breathable air in oxygen-deficient atmospheres. Respirators are of two general types:

a. air-purifying units which use filters and/or absorbent cartridges to remove contaminants from ambient air.
b. air-supplying devices, including SCBA respirators or airline respirators to provide a separate source of breathing air.

It is important to know that there are also different types of respirators within these two broad categories and many are not appropriate for protection against multiple hazards. Some are only designed to protect against specific air contaminants.

For these reasons, it is imperative that specific inhalation hazards be identified beforehand and the correct respirator selected. To ensure this and to comply with the OSHA Respiratory Protection Standard (29 CFR 1910.134), all laboratory personnel who need respirators must first receive respirator training and a respirator fit-test. There are no exceptions to these rules. Contact the UNLV Chemical Hygiene Officer if you believe your work requires wearing a respirator.

B. Eye and Face Protection

Safety glasses are required to be worn by all personnel whenever they are performing, observing, or supervising work operations where there is a realistic possibility of injury to the eyes. While safety glasses are worn primarily to prevent physical injury to the eye, they can also provide some protection from chemical contact. Chemical splash goggles are specifically designed to prevent contact from splashes or sprays of chemicals. Face shields provide additional protection to the eyes and face. Occupational safety eyewear should meet or exceed ANSI Z87.1 - The American National Standard Institute Practice for Occupational and Educational Eye and Face Protection.

Contact lenses should not be permitted in areas where chemicals are used or stored, because they may intensify the effects of a chemical exposure. In a dusty environment, dust particles can become lodged behind a contact lens and can cause irritation or scratching of the lens of the eye. Contact lenses can also absorb some organic vapors from the air and thus concentrate them at the surface of the eye. This material can then do damage at the eye and will not be flushed out if the eye is irrigated following an accident. Contact lenses should also be restricted in areas of radiant or intense heat or where splashes of liquids are likely.

C. Hand Protection

Many chemicals and chemical solutions have an irritant or corrosive effect on the skin. Other chemicals can be absorbed through the intact skin, without immediate symptoms, and thus may cause injury to internal organs. In laboratory-scale work, the hands are the part of the body most susceptible to skin contact. A variety of gloves are available which may be used to prevent chemical exposure. Many manufacturers also publish glove charts which can be used to select gloves made of the proper materials. All materials are permeable to some extent but a suitable glove is one that has an acceptably low permeability for the chemical under the conditions of expected use. If you are uncertain as to which glove to use, contact the UNLV Chemical Hygiene Officer for additional information.

Other types of chemical protective clothing include aprons, lab coats, boots, and overalls. These may be required for added protection. Contact the UNLV Chemical Hygiene Officer for specific advice.

V. Employee Information and Training

A. Laboratory Hazards

All employees must be made aware of the hazards presented by the chemicals in use in the laboratory. Each laboratory employee shall receive UNLV Chemical Hygiene Awareness Training at the time of initial assignment to the laboratory. They shall also receive specific laboratory and procedural training from their Principal Investigator or laboratory manager of the hazards in their work area upon initial assignment and prior to assignments involving new exposure situations. <u>All lab specific training should be documented.</u> Regular refresher training is recommended.

Laboratory hazards include:

1. Compressed Gases

All compressed gas cylinders are hazardous **regardless** of the contents. Types of compressed gases include:

a. Inert: a non-flammable, non-reactive gas that is not considered to be hazardous unless the gas is uncontrollably released. These gases still have a potential for asphyxiation (oxygen depletion). Examples include nitrogen or helium in compressed or cryogenic liquid form.
b. Flammable: a gas which may ignite at concentrations between the upper and lower explosive limits (examples are Hydrogen and acetylene).
c. Oxidizing: may promote rapid combustion of flammable gases or materials (an example is nitrous oxide).
d. Corrosive: reactive gas which may degrade materials and cause damage to bodily tissues upon contact (an example is hydrogen chloride).
e. Toxic: a poisonous gas which may cause acute reactions or death (an example is hydrogen sulfide).

The following safety precautions shall be followed:

- All compressed gas cylinders must be clearly labeled as to their contents.
- All compressed gas cylinders must be secured to the wall or a sturdy table by a clamp, belt, or chain at all times.
- When not in use, all compressed gas cylinders must have a valve cap on.
- At the time of receipt of hazardous/flammable gases and whenever regulators are changed, check for leaks with a soap bubble solution (commercially available preparations are available).
- Check a catalog for the proper regulator before connecting any regulator to a cylinder. Slowly open the valve in case of a leak or damaged regulator.

- Never use adapters to connect an unsuitable regulator to a compressed gas cylinder.
- Move cylinders only with the aid of a cylinder transport cart with a restraining strap or chain.
- Run only rigid tubing that is compatible with the gas used, from the cylinder to the instrument.
- Never store oxidizing gases with flammable gases.

2. Flammable Liquids

Liquids having flash points below 100º F. are highly flammable. Amounts less than five gallons may be stored in a typical lab. Larger quantities require a flammable liquid storage cabinet which is designed to provide physical and thermal protection.

3. Corrosive Substances

Corrosives cause irritation, chemical burns, and can cause tissue destruction, as described above. Safety showers and eyewash stations must be provided. Gloves and other personal protection equipment must also be provided. Nose, throat, and lung injury can result by inhaling these vapors. The irritating quality of corrosives provides a warning.

4. Biological Hazards

The safe use and disposal of biological agents is covered under the UNLV Institutional Biosafety Program. Please be aware that any procedures involving Biosafety Level 2 (BSL2) organisms or higher are subject to review and approval. You must notify the Research Compliance Office and submit a detailed protocol to the Institutional Biosafety Committee (IBC) before starting any work.

B. Training

Training – UNLV Chemical Hygiene Training shall include awareness as to the presence of a hazardous chemical, physical and health hazards of chemicals in the lab, and measures employees can take to protect themselves from these hazards. The training shall present the details of the Chemical Hygiene Plan and reflect the new standards as suggested by the UN Global Harmonization Standard Initiative, and shall include:

1. The contents of the OSHA laboratory standard and its appendices
2. The location and availability of the Chemical Hygiene Plan
3. Permissible exposure limit awareness for OSHA regulated substances or recommended exposure values for other hazardous chemicals not regulated by OSHA which are present in the laboratory
4. Signs and symptoms associated with exposure to the chemicals present in the laboratory
5. Location and availability of reference material on chemical hygiene
6. The methods and observations that may be used to detect the presence or release of a hazardous chemical

7. The physical and health hazards associated with unsafe use of the chemicals in the laboratory
8. The measures employees can take to protect themselves from these hazards including but not limited to: appropriate work practices, emergency procedures, and personal protective equipment to be used

C. Safety Data Sheets (SDS)

A Safety Data Sheet (SDS) is a document containing chemical hazard and safe handling information that is prepared in accordance with the OSHA and the GHS Hazard Communication Standard.

1. Chemical manufacturers and distributors must provide the purchasers of hazardous chemicals an appropriate SDS for each hazardous chemical purchased.
2. If an SDS was not provided with the shipment of a hazardous chemical, one must be obtained from the manufacturer.
3. The Chemical Hygiene Officer and the Chemical Information Officer of RMS will assure that the SDS's of chemicals known to be on campus are on file are current and accurate. If a researcher brings a chemical on campus, then it is their responsibility to provide one to RMS so it can be added to our database. This includes experimental compounds.
4. SDS's are available to all employees.
5. All Safety Data Sheets will be scanned & are retained electronically on the Risk Management & Safety website. If you want to consult an SDS, either visit the website or request an SDS hardcopy from Risk Management & Safety.

Warning: It must be noted that the GHS hazard numerical guidance is opposite that of OSHA and NFPA. OSHA is still the regulatory agency of authority in the U.S. and is not changing their hazard scale. So make sure which hazard level reference you are citing or using.

D. Labels

A label is any written, printed, or graphic material displayed on or affixed to containers of hazardous chemicals.

1. Existing labels on new containers of hazardous chemicals or containers in storage shall not be removed or defaced. Employees should not work with a hazardous chemical from an unlabeled container except from a portable container intended for the immediate use by the employee who performs the transfer. Labels or other forms of hazard warnings, such as tags or placards, provide immediate warning of potential danger. They may be used to warn of a variety of potential physical hazards or health hazards.
2. It may be impractical to print all the hazard information on the label. Be sure that when making secondary label containers you, at minimum, include the name of the chemical, hazards, date prepared and individual preparing the

material. The worker applied hazard labels must be understandable by ANYONE, not just immediate lab personnel.

3. Read all the information on the label. If you do not understand something, contact your supervisor for an explanation or request an SDS.
4. Original product labels must contain the following information:
    a. Contents of the container
    b. Name (and address) of the manufacturer
    c. Physical and health hazards (the SDS must be available for more complete information)
    d. Recommended personal protective equipment (the SDS must be available for more complete information).
    e. Date received or opened applied by the user. (Recommended)

VI. Approval for Laboratory Operations

Chemical Hygiene Evaluations - these are made by the researcher or lab manager to determine the type and extent of appropriate control procedures are needed that minimize worker exposure to chemicals. Examples of when evaluations shall be performed include the following:

It is likely that toxic concentrations could be exceeded or that other harm is likely.
There is a change in procedure or test, even if it is very similar to prior practices.
"Change in a procedure or test" means: A 10% or greater increase or decrease in the amount of one or more chemicals used.
A substitution or deletion of any of the chemicals in a procedure.
Any change in other conditions under which the procedure is to be conducted.
There is a failure of any of the equipment used in the process, especially of safeguards such as fume hoods or clamped apparatus.
There are unexpected results that require adjustments.
Members of the laboratory staff become ill, uncertainty that they or others have been exposed, or otherwise suspect a failure of any safeguards.

VII. A Medical Consultation and Examination

Medical supervision of laboratory workers is another step in the series of control measures that deal with potential chemical exposures. Various aspects of the medical program are described in this section.

It is the responsibility of each UNLV department to ensure that the baseline medical examination for use of a respirator in conjunction with hazardous material work is performed for those personnel working with hazardous substances, and to coordinate the procurement and scheduling of the medical exam for those employees.

A. Medical Contact

Employees who work with hazardous chemicals must contact the Risk Management and Safety Department under the following circumstances:

1. Whenever an employee develops signs or symptoms associated with a chemical to which the employee may have been exposed or upon any significant changes in health.
2. When routine monitoring reveals an exposure above applicable personal exposure limits.
3. When an event takes place in the work area such as a spill or leak, explosion or other occurrences resulting in the likelihood of an acute exposure.
4. When there are medical surveillance requirements for OSHA regulated substances or activities.
5. When the Chemical Hygiene Officer determines that an individual assessment should be made with respect to specific hazardous substances or specific work processes.

B. Medical Examination

Medical examinations and consultations must be performed by a licensed physician or under a physician's direct supervision. Such services will be provided without cost to the employee, without loss of pay and at a reasonable time and place.

C. Employee Information

The following information should be provided to the physician by the employee:

1. The identity of the hazardous chemicals to which the employee may have been exposed.
2. A description of the conditions under which the potential exposure occurred.
3. A description of the signs and symptoms of exposure that the employee is experiencing, if any.

D. Physician's Report

The results of any laboratory tests, biological monitoring, physical examinations, and diagnoses will be entered into the employee's medical record. In addition, a written medical opinion, when required by regulation, will include:

1. Any recommendation for further medical follow-up including periodic biological testing.
2. A description of the results of the examination and any associated tests.
3. Any medical condition that is revealed in the course of the examination that may place the employee at increased risk, if exposed to a hazardous substance in the workplace.
4. A statement that the employee has been informed by the physician of the results of the examination and any medical condition which may require further evaluation or treatment.

Specific diagnosis unrelated to occupational exposure will not be revealed to anyone except the employee. These documents are available to the employee and will be kept for 30 years as required by OSHA.

VIII. Additional Employee Protection

A. Particularly Hazardous Substances

The OSHA Laboratory Standard includes specific regulations for work with particularly hazardous substances such as "select carcinogens", reproductive toxins, and substances which have a high degree of acute toxicity. One very basic requirement is establishing a "Designated Area" for the experimental use of carcinogens, if deemed to be necessary by the Chemical Hygiene Safety Officer.

The area may consist of an entire laboratory, part of a laboratory, or even a containment device such as a laboratory hood or glove box. The "Designated Area" must be clearly identified by signs. Personnel who are not directly involved with the work must be excluded. Other requirements deal with operating and personnel practices and with assigned responsibilities.

1. Special Case for Substances Developed in the Laboratory - the following provisions shall apply to chemical substances developed in the laboratory:
    a. if the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical, which is defined as greater than 10 milligrams of any carcinogen, reproductive toxin, substance that has a high degree of acute toxicity, or a chemical whose toxic properties are unknown. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required.
    b. if the chemical produced is a byproduct in which composition in not known, the employer shall assume that the substance is hazardous and implement appropriate safeguards.
    c. if the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1912.1200) including the requirements for preparation of Safety Data Sheets and labeling.

2. Carcinogens
    a. Definition (29 CFR part 1910.1450) - "Select Carcinogen" means any substance which meets one of the following criteria:
        i. it is regulated by OSHA as a carcinogen; or
        ii. it is listed under the category, "known to be carcinogens", in the Annual Report of Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
        iii. it is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or

iv. it is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
    1. after inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to concentrations of less than 10 mg/m3; or
    2. after repeated skin application of less than 300 mg/kg of body weight per week; or
    3. after oral dosages of less than 50 mg/kg of body weight per day.

b. Locations and/or Operations Handling Carcinogens:
    i. The locations and/or operations handling carcinogens must be identified and labeled properly.

c. Procedures for Working with Carcinogens:
    i. Procedures using particularly hazardous substances will undergo a chemical hygiene evaluation or Hazard Assessment. Issues such as the need for a designated area, containment equipment, segregated waste disposal and decontamination of the area and equipment will be given particular attention during this evaluation.

3. Reproductive Toxin
    a. Definition - any substance described as such in the applicable SDS. Additional terms which identify reproductive toxins if they appear on the SDS sheet are as follows:
        i. Male Reproductive Toxicity: Reproductive toxins are those that adversely affect the ability of adult males to reproduce. In males, adverse effects on fertility include sperm damage, reduced libido, and impotence. Examples of Male reproductive toxins include lead, dibromochloropropane (DBCP) and some glycol ethers. There is no known measurable effect of chronic, low levels of non-ionizing or ionizing radiation on male fertility.
        ii. Female Reproductive Toxicity: Adverse effects of toxic chemicals on female fertility generally include effects on the egg or on the female hormonal cycle; manifestations of the latter may include irregular menstrual cycles, poor implantation, or abnormal development and function of the placenta. Examples of female reproductive toxins include lead, mercury and some organic solvents. There is also no known measurable effect of chronic, low levels of nonionizing or ionizing radiation on female fertility.
        iii. Developmental Toxicity: Developmental toxins are those that adversely affect the offspring. During the first three months of pregnancy (the period of organ formation), the fetus is particularly sensitive to the toxic effects of chemicals because the cells are rapidly dividing and the fetus lacks the ability to detoxify foreign substances. Examples of developmental toxicity include fetal death, postnatal growth retardation, specific organ system

dysfunction, and developmental disabilities including hearing and vision impairment.

iv. Teratogenicity: A teratogen is a specific development toxicant that produces irreversible and harmful structural malformations as a consequence of exposure during pregnancy. Teratogenic effects are not inherited. Examples of teratogenic chemicals include the drugs Thalidomide and diethylstilbestrol (DES).

b. Locations and/or Operations Handling Reproductive Toxins:

i. The locations and/or operations handling reproductive hazards are to be identified and labeled.

c. Procedures for Working with Reproductive Toxins:

i. Procedures using particularly hazardous substances will undergo a chemical hygiene evaluation. Issues such as the need for a designated area, containment equipment, segregated waste disposal and decontamination of the area and equipment will be given particular attention during this evaluation.

4. Acute Toxins

a. Definition

i. Acute Toxin: A chemical is considered to be a health hazard when it meets any of the definitions originally outlined in the OSHA Hazard Communication Standard. Specifically, the definitions are:

ii. Toxic: A material having (1) an LD50 between 50 to 500 mg/kg when administered orally to albino rats weighing 200 to 300 g. each; (2) an LD50 between 200 to 1000 mg/kg when administered by continuous contact for 24 hours to the bare skin of albino rabbits weighing 2-3 kg each; or (3) an LC50 between 200 to 2000 ppm. (In air or vapor) or 2 to 20 mg/liter (mist, fume, or dust) when administered by continuous inhalation for one hour to albino rats weighing 200 to 300 g. each.

b. Location and/or Operations Handling Acute Toxins:

i. The locations and/or operations handling acute toxins are to be identified and labeled.

c. Procedures for Working with Acute Toxins:

i. Procedures using particularly hazardous substances will undergo a chemical hygiene evaluation. Issues such as the need for a designated area, containment equipment, segregated waste disposal and decontamination of the area and equipment will be given particular attention during this evaluation.

B. Chemical Spills, Releases, and Accidents

1. Preventing Leaks and Spills

The first and best method of spill control is prevention. By using the proper equipment and handling techniques, spills and leaks can be prevented in almost all cases. Some specific suggestions for preventing leaks and spills are:

a. Hazardous Materials Management Plan for all but the simplest systems.
b. Provide a physical arrangement that permits easy manipulations and material transfers.
c. Leak-test the system before introducing flammables or toxins.
d. Make practice runs with inert or non-flammable materials as a final check.

2. Spill Containment

Provide for containment of spills as a backup to the preventive steps described above. Trays or catch-pans under apparatus where leaks or spills may occur, greatly simplify the clean-up problem. These should be large enough to contain the maximum possible spill.

3. Spill Control and Clean-up

Spills are handled on a two-tier basis that depends on the size and location of the problem. You should be prepared to clean up most spills, but if you cannot safely handle even the smallest spill immediately notify Risk Management and Safety and follow the established emergency procedures for your laboratory, as specified in the UNLV Emergency Procedures Manual.

a. Small Spills: Spills that involve less than 1 quart of hazardous material in a laboratory area are usually handled by the laboratory occupants. However, with some materials, the size of the spill may be negated. If a spill of any quantity of the following materials or situations, or when laboratory workers feel that they cannot handle the spill, or are feeling health effects due to the spill, the spill shall be treated as a Large Spill and reported to Risk Management and Safety (x5-4226).
    i. All spills of extremely flammable materials (flash point less than 20 F)
    ii. All spills of extremely toxic materials (LD50 of less than or equal to 5 mg/kg)
    iii. All mercury spills
    iv. All personal contaminations
    v. All leaking containers
    vi. All uncontrolled compressed gas releases

Spill kits should be kept in stock for acid absorption and neutralization, caustics absorption and neutralization, and flammables.

Use polypropylene felt absorbent pads for acid, caustic and flammable spills. During cleanup, wear protective equipment such as but not limited to: gloves; chemical goggles or face shield; chemical apron or lab coat; and the proper respiratory protection for the material. Specific information is also given in the Safety Data Sheets.

b. Large Spills: When there is a spill that is larger than you can comfortably manage or is outside of your work area, or there is an unusual problem, immediately notify the Risk Management and Safety Department (895-4226 or 911) and follow the established emergency procedures for your

laboratory. The following information should be available for emergency response personnel:

i. The name of the substance involved.
ii. The quantity spilled.
iii. The location of the spill.
iv. Your name and the phone number

You should do the following until emergency response personnel arrive:

a. Leave the immediate area.
b. Keep others away.
c. If the spill presents a hazard to others in the building, and the building needs to evacuated, use a fire alarm pull box on the way out of the building to activate the evacuation alarm.
d. Remain at or near the scene to provide further information that may be needed by emergency response personnel.

4. Personal Contamination

Quick action is extremely important! Use the eyewash or emergency shower to remove material from eyes or skin. Flush eyes or skin for at least 15 minutes. Keep your eyes open to properly wash out the chemical! If clothing is contaminated remove it as you shower. Get help from someone nearby to do the following:

a. Request medical or first aid assistance.
b. Notify the Risk Management and Safety department of the incident.
c. Report the location of persons injured.
d. Report the type of injury.
e. Report the substance or substances involved.
f. Report the number of persons injured.

Employees affected by a spill, leak or explosion must seek immediate medical attention.

IX. Recordkeeping

A. Exposure and Medical Records

Employees and their representatives have the right to access occupational health exposure and medical records. Exposure records include: area and personal sampling data, Safety Data Sheets, and industrial hygiene analyses. Medical records include:

physical examinations, biological monitoring, diagnoses, x-ray and laboratory reports.

All information requests shall be in writing to the Department of Risk Management & Safety. A copy of the OSHA Standard pertaining to employee access to Exposure and Medical Records is also available through the Risk Management & Safety Department.

X. Annual Chemical Hygiene Program Audit

An audit of the entire chemical hygiene program will be conducted at least annually.

Appendix A - Safe Storage of Chemicals

Chemicals must be stored in a safe manner and in accordance with manufacturer's recommendations. Some specific guidelines include:

- Hazardous liquid chemicals should be stored below waist level.
- Corrosives should be stored in specially designed corrosive cabinets.
- Flammables should she stored in specially designed solvent storage cabinets with self-closing doors.

Incompatibles must be segregated. The following are the UNLV segregation recommendations by hazard class. This hazard classification system is integrated with our chemical management program and you may request a copy of your chemical inventory sorted by hazard class for ease of segregation from Risk Management and Safety.

Hazard Classes

The following groups should be separated:

1. **COR** - acids and bases – acids should be segregated from all other materials preferably in an acids cabinet. Within the acid category oxidizing acids should be segregated from organic acids. Bases should be segregated from all other materials.
2. **OX1, OX2, OX3, OX4** - oxidizing agents should be stored away from reducing agents and combustible/flammable materials.
3. **EXP** - potentially explosive materials – should be individually analyzed and stored according to manufacturer recommendations
4. **WR1, WR2, WR3** - water reactive materials - should be stored in cool, dry place away from any water source.
5. **PYR** - pyrophoric chemicals – should be stored in a cool, dry place making provisions for an airtight seal.
6. **OP1, OP2, OP3, OP4, OP5, OPD** - organic peroxides - these must be properly managed and disposed of within recommended time periods. Label containers with receiving, opening and disposal dates.
7. **F1A, F1B, F1C, CL2, C3A, C3B** – flammable & combustible liquids – should be stored in a flammable liquids cabinet segregated from other types of chemicals.
8. **UR1, UR2, UR3, UR4** – Unstable/reactive – further evaluation for compatibility within this category must occur. Unstable/reactive chemicals generally have storage precautions specified by the manufacturer.
9. Chemicals with health hazards including irritants (**IRR**), carcinogens (**CAR**), Sensitizers (**SEN**), Toxic (**TOX**), Highly toxic (**HTX**) and other health hazard (**OHH**) should be stored in a specially designated "health hazard" cabinet.
10. **NON** – Non-hazardous – can generally be stored in general chemical storage area unless special storage is indicated by the manufacturer.

Appendix B - Flammables

Many organics are flammable and should be treated accordingly. When flammable materials are used, care should be taken to avoid a flammable or explosive mixture with air.

A general rule is that controls should be in place (or quantities limited) so that the concentration of a flammable will not exceed 10% of the lower explosive limit (please refer to NFPA 45, "Fire Protection for Laboratories Using Chemicals", for the quantities of flammables allowed in the laboratory and storage requirements). A list of selected explosive limits is shown below. If it is necessary to have the concentration of a compound in the explosive range, all sources of ignition must be excluded.

Selection and Use of Refrigerators

1. Ordinary Refrigerators
    a. Are not designed for flammable chemical storage because they have hot surfaces (light bulb), possibly sparking switches, heating tapes, drains for the condensation to run out, and potential ignition sources from the motor.
    b. Are not for storage of flammable materials. Motor produces sparks outside the storage area.
    c. Not designed for use in hazardous environment
2. Refrigerators for Flammable Materials
    a. This type of refrigerator is specially designed for storing flammable liquids. Magnetic door seals (to avoid pressure build-up). No parts that can emit sparks or hot surfaces inside. The motor and motor controls may generate sparks are electrically insulated and outside the storage area.
    b. For use in ordinary laboratory
    c. No sparks or hot surfaces, but motor produces sparks outside the storage area.
    d. Not for use in hazardous environment
3. Explosion-Proof Refrigerators
    a. This provides a safe spark free interior and can be used in a hazardous environment (Class I, Division I & II Group C and D applications).
    b. For storage of flammables
    c. Uses magnetic door latches and produces no sparks, has no hot surfaces
    d. For use in hazardous environments

Control of Vapors within a Refrigerator

In spite of the lower temperatures, the odors tend to accumulate in a refrigerator or freezer and are then released into the laboratory and become another source of exposure.

It is possible to ventilate a refrigerator by installing a slot hood along the edge of the door. The door is opened only a couple of inches and held there a few minutes. The slot

ventilation causes the air to sweep through the refrigerator and out the ventilation system. This system has some disadvantages.

- Moisture condenses on the cold surfaces of the contents of the refrigerator.
- There is a 5-minute wait.

Another method which is very satisfactory for reducing the vapors of pesticides and many solvents is to place a tray of activated charcoal in the refrigerator. The charcoal should be handled in the hood because of the dust but it effectively controls many vapors.

Vented Fire Cabinets

Fire safety cabinets are required by regulation to be vented in many localities. The ventilation rate specified in the manual is 5-2O CFM provided by a roof mounted motor. The inlet should have a spark arrestor.

However, the NFPA has not taken a position on the venting of fire safety cabinets. The cabinets were designed to protect the contents of the cabinet from fire and were not designed as storage cabinets. The concern is whether forced venting affects the fire rating.

Appendix C - Peroxide Forming Compounds

Under normal storage conditions, peroxidizable compounds can form and accumulate peroxides which may explode violently when subjected to thermal or mechanical shock. The following lists give examples of peroxidizable compounds with recommended discard periods.

Discards Periods for Peroxide Formers

1. Peroxide Hazard on Storage – Discard Three Months After Opening
    a. Divinyl Acetylene (Dangerous)
    b. Isopropyl Alcohol
    c. Isopropyl Ether
    d. Potassium Metal
    e. Sodium Amide
    f. Vinylidene Chloride
2. Peroxide Hazard on Concentration – Discard One Year After Opening
    a. Acetal
    b. Cumene
    c. Cyclohexene
    d. Diacetylene (Extremely Dangerous)
    e. Dicylopentadiene
    f. Diethyl Ether
    g. Dioxane
    h. 1,2-Dimthoxyethane (Glyme)
    i. Indene
    j. Methyl Acetylene
    k. Methyl Cyclopentane

l. Methyl Isobutyl Ketone
m. Tetrahyrofuran
n. Tetralin
o. Vinyl Ethers

3. Hazard of Peroxide-Initiated Polymerization -- Discard One Year After Opening
   a. Acrylonitrile
   b. Acrylic Acid
   c. Butadiene
   d. Chlorotrifluoroethylene
   e. Styrene
   f. Vinyl Acetate
   g. Vinyl Acetylene
   h. Vinyl Chloride
   i. Vinyl Pyridine
   j. Methyl methacrylate

Appendix D – UNLV Laboratory Check-Out Form

General	Completed	Date Completed	Questions
Contacted RM&S at least 1 month prior to move/leaving	□Yes □No □N/A	/ /	5-0463
Emergency Numbers & door sign removed	□Yes □No □N/A	/ /	5-4226
All potentially contaminated surfaces & equipment decontaminated (inspected by RSO if radioactive materials were used)	□Yes □No □N/A	/ /	5-0463
All chemicals assigned to another faculty member or disposed of (including gas cylinders)	□Yes □No □N/A	/ /	5-4226
Faculty member assuming responsibility for chemicals:			
All hazardous waste disposed of properly	□Yes □No □N/A	/ /	5-4942
IBC protocols inactivated	□Yes □No □N/A	/ /	5-0463
IRB protocols inactivated	□Yes □No □N/A	/ /	5-2794
IACUC protocols inactivated	□Yes □No □N/A	/ /	5-3384
Select agents disposed of/transferred, registration inactivated	□Yes □No □N/A	/ /	5-4226
RSO notified of termination of use of radioactive materials	□Yes □No □N/A	/ /	5-4419
All stickers & signs removed from equipment (biohazard, radioactive material, hazardous chemical)	□Yes □No □N/A	/ /	5-4942