Chemical Hazards – Recognition, Evaluation and Control

1. RECOGNITION OF CHEMICAL HAZARDS

Working with chemicals always involves the risk of exposure. It is important to review and understand any information about hazards and special precautions regarding the handling and use of a chemical. Hazardous chemicals can be classified into four types of hazards:

- Flammable
- Corrosive
- Reactive
- Toxics (e.g. acute poisons, carcinogens, mutagens, teratogens, etc.)

In general, chemicals should be stored with other chemicals of the same type and all chemicals should be stored in secondary containment. Chemical exposure should be minimized as much as possible through the use of engineering controls like chemical fume hoods, through work practices that minimize volumes and substitute less hazardous materials, and through personal protective equipment (PPE) like gloves, splash goggles, and lab coats.

2. EVALUATION OF CHEMICAL HAZARDS

A. Safety (Material) Data Sheets (SDS's)

1. An SDS outlines a substance's physical and chemical hazards that include but are not limited to:
    - Identity Information
    - Hazardous Ingredients
    - Physical/Chemical Characteristics
    - Fire and Explosion Hazard data
    - Reactivity Data
    - Health Hazard Data
    - Precautions for Safe Handling & Use
    - Control Measures
2. In accordance with the UC Davis Hazard Communication Program, companies that sell hazardous substances to UCD are required to provide an SDS on each substance and mixture of hazardous substances.
3. Accessing SDS'S's
    i. From the EH&S office:
    Contact EH&S at (530) 752-1493 for technical assistance.
    ii. Internet Resources
    The EH&S Homepage has identified sites having large collections of SDS'S's and are a good place to start your search.
    https://safetyservices.ucdavis.edu/units/ehs/research/safety-data-sheets

B. Health Effects of Chemicals

Working with chemicals always involves the risk of chemical exposure. The health risk is dependent upon the toxicity of the chemical, the types of effects and the various routes of entry.

1. Toxicity vs. Hazard

Toxicity	ability of a chemical to act as a poison or cause injury to tissues.
Hazard	likelihood that a chemical will cause injury in a given environment or situation; degree of hazard depends on how toxic the substance is, how it is absorbed, etc

2. Acute vs. Chronic Exposures

Acute Exposures	exposure of short duration, usually to relatively high concentrations or amounts of material
Chronic Exposures	continuous or intermittent exposure extending over a long period, usually to relatively low material amounts or concentrations.

3. Local vs. Systemic Effects

Local Effects	effects of the chemical may be localized on a specific area of the body such as nose or throat
Systemic Effects	entire body system and organs are all affected by exposure to the chemical

C. Threshold Limits Values - TLV-TWA

Most health effects are dependent on the level of concentration of the exposures. The TLV-TWA is the allowable time-weighted average (TWA) airborne concentration of a material to which most workers can be exposed, during a normal 8-hr workday or 40-hr week, without adverse effects.

D. Dose - Response Relationship

Toxicological studies show that there is a relationship between the chemical dose and the response that is produced in the body. For example, a small amount of formaldehyde will effect minutely on the biologic tissue while large amounts of the same chemical will cause severe effect in a biologic system. This dose-response relationship can be plotted out.

E. Routes of Entry

There are various routes of entry whereby chemicals can gain entrance into the physical body. These routes are:

1. Inhalation
2. Skin Absorption
3. Ingestion
4. Injection

F. Target Organ Effects

Chemically caused effects from exposure to a material on a specific listed organs and systems such as liver, kidneys, nervous system, lungs, skin, and eyes.

3. CONTROL METHODS FOR CHEMICAL HAZARDS

A. Designated Area

This is an area assigned for the usage of either a particularly hazardous substance or purpose. For example, if carcinogens are being used in the lab, a "designated area" should be assigned, and warning label should be posted.

1. Clean Area

There are no longer clean areas allowed in an active research laboratory.

B. Engineering Controls

This is the most effective and desirable method for minimizing risk of exposure either to toxic chemicals or to mechanical equipment. Examples of engineering controls: guards, remote controls, or interlock systems

However, for toxic fumes, mists, and vapors, ventilation systems are the best approaches to help reduce personal exposure to acceptable levels. Generally, there are two types of ventilation systems:

1. Dilution Ventilation
   In most buildings a certain percentage of the building air is recirculated periodically through the building ventilation systems but in laboratories all air is exhausted directly to the outside. This “single pass” system is a type of “dilution ventilation” system for controlling low risk airborne contaminants. They are simply exhausted to the outside before they can build to hazardous levels.
2. Local Exhaust Ventilation
   Used for moderate to high-risk contaminants. Local exhaust systems capture the airborne contaminants much more effectively than dilution systems such as chemical fume hoods
3. Fume Hoods
   The fume hood is designed to contain and disperse gases, vapors, and aerosols to the external environment. It does not provide absolute containment or protection from the materials in the hoods, however, a properly designed hood in a properly designed room can provide adequate protection of the following practices are observed:
   - Inspect and ensure that the hood is working.
   - Do not store chemicals and equipment in the hood
   - Remove unnecessary chemicals and equipment.
   - All equipment and experiments should be at least 6 inches back from the front sash.
   - Position the sash no higher than the approved working height that is designated by a fluorescent yellow sticker.
   - When evaporating or distilling perchloric acid, special perchloric acid fume hoods MUST be used.

C. Work Practice Controls

In most cases, a well-designed set of work practices is the best risk management tool.

1. Chemical Transportation
   Assure that an unbreakable secondary container is being used, and that transport carts are designed for this purpose.
2. Eating and Drinking
   There should be no eating, drinking, chewing of gum or tobacco, application of cosmetics, storage of utensils, food, or food containers in the laboratories.
3. Pipetting
   Mechanical pipetting aids should always be used for all pipetting procedures. Oral pipetting is prohibited
4. Personal Hygiene
   All personnel should wash their hands immediately after the completion of any procedure in which chemicals have been used and when they leave the laboratory. If hazardous chemical exposures occur to skin, immediately shower or wash affected areas for 15 minutes.
5. Housekeeping
   Keeping the working area clean and orderly reduces the frequency and severity of accidents. Here is some common sense tips:
   - Keep aisles, exits, stairs and hallways free of obstructions.
   - Avoid slip hazards by keeping the floor clean of ice, stoppers, glass beads or rods, other small items and spilled liquids.
   - Keep drawers and cabinet doors closed.
   - Never store chemicals on the floor.
   - Workspaces and storage areas should be kept clear of broken glassware, leftover chemicals and scraps of paper.
   - Place all non-contaminated broken glass in rigid containers with plastic liners clearly marked "Broken Glass".

D. Standard Operating Procedures (SOP)

Lab staff should prepare a SOP for hazardous operations as well as the use, storage and disposal of hazardous materials. SOPs serve as a training tool for new workers. SOP templates for common hazard classes can be found here: https://safetyservices.ucdavis.edu/units/ehs/research/chemical/sop-templates

E. Personal Protective Equipment (PPE)

1. PPE comprises of clothing or equipment that is used to isolate a worker from direct exposure to workplace hazards. Examples of PPE include the following:
   a. Protective clothing
   b. Gloves
   c. Eye Protection
   d. Respirators
   e. Face Shields

   PPE is used in conjunction with engineering and administrative controls for worker protection. It should provide adequate protection if it is properly worn and appropriately used. Prior to usage, consult your online Laboratory Hazard Assessment Tool (https://safetyservices.ucdavis.edu/units/ehs/research/laboratory/lhat) or EH&S (752-1493) to ensure proper PPE selection.

2. **Guidelines for PPE Usage**
    a. PPE protects differently for each hazard. It does not provide protection against all hazards. Choose appropriate PPE depending on the hazard and task you are performing. Remember: USING THE WRONG PPE MAY BE AS BAD AS USING NO PPE!
    b. PPE does not eliminate the hazard. Know the limitations of PPE. Follow SAFETY PRECAUTIONS while working.
    c. Use and maintain PPE properly to ensure its performance. Having safety goggles does no good if it's resting on your head.
    d. Be aware that there may be hazards with using PPE. Talk to your supervisor or EH&S before using PPE.
    e. PPE does not protect workers the same way! PPE should be properly sized and fitted to ensure its adequacy.
    f. Wear more than the minimum PPE.
    g. Leave your uniform at work and have it laundered there if a service is provided. If you take your uniform home, then wash it separately to avoid contaminating other clothes.
    h. Take off your jewelry (i.e. rings and watches). This reduces chemical seepage and contact with electrical sources.
3. **Protective Clothing**
    - Lab clothing (i.e. coats and aprons) should be worn in the laboratories in order to keep contaminants from getting onto street clothes.
    - Open-toed/open-heeled shoes, sandals or shoes made of woven material should not be worn in the laboratory.
    - Shorts, cut-offs and miniskirts are inappropriate.
    - Long hair and loose clothing should be constrained.
    - Jewelry (i.e. rings, bracelets, and watches) should not be worn in order to prevent chemical seepage under the jewelry, contact with electrical sources, catching on equipment and damage to jewelry itself.
4. **Gloves**
    Appropriate gloves should always be used when working in the lab. Disposable gloves should be discarded after each use and immediately after overt contact with chemical.
5. **Eye Protection**
    Devices to provide appropriate eye protection should be used in the laboratory work area. The type of device used will depend upon the hazard presented by the operation and/or chemical in use. Splash goggles (vented or non-vented) are most appropriate when working with liquid chemicals.
6. **Respiratory Protection**
    At times, masks or respirators may be required for some procedures where there may be a potential for inhalation exposure. However, respirator users should consult EH&S to assure accordance with the UCD Respiratory Protection Program.

F. Chemical Hygiene Plan (CHP)

The CHP is designed to protect you from the health hazards associated with hazardous chemicals in your lab. The CHP outlines standard operating procedures for all work involving hazardous substances in your lab. The CHP must be available to employees in the lab at all times.

G. Chemical Storage

1. Chemical Storage
   - Separate incompatible chemicals. Check the shelf life of your chemical inventory periodically.
   - Store chemicals properly in the cabinets or on the shelves provided.
   - Do not store chemicals in fume hoods.
   - Install smoke and heat detectors and fire extinguishers.
   - Do not overcrowd or overload shelves.
   - Keep storage facilities locked.
   - Keep aisles clutter-free and unobstructed.
2. Labeling

   Since there is a wide variety of chemicals used in the laboratories, appropriate labeling is extremely important. In order to be able to determine its use, disposal and hazards, the UC Davis Hazardous Communication Program requires chemicals to be properly labeled.
3. Flammable Storage Cabinets
   - Flammable cabinets are designed to protect flammable liquids against flash fire; the cabinet should ALWAYS remain closed when not in use.
   - Ensure cabinet can contain any spilled flammable liquids to prevent fire spread.
   - Cabinet should only accommodate up to 60 gallons of flammable liquids.
   - All cabinets should be UL (Underwriter's Laboratory) Approved and labeled "Flammable - Keep Fire Away".
4. Lab Refrigerators
   - Use only an EH&S approved "lab safe" refrigerator designed for storing chemicals.
   - NEVER store chemicals and food in the same refrigerator.
   - If not "lab safe" refrigerator, it MUST be labeled "Caution - Unsafe For Storage Of Flammable Solvents".
5. Special Considerations
   - Store carcinogens separately.
   - Store water-sensitive chemicals and concentrated acids separately.
   - Use heat-resistant cabinets for flammable liquids.
   - Wooden cabinets are acceptable for solids.
   - Peroxide forming chemicals deserve special consideration. Due to unusual stability problems, careful records of the storage history of compounds that form peroxides on standing should be maintained and periodically reviewed. Discard peroxide forming chemicals by the manufacturer's

expiration date or after 6 months of opening, whichever is sooner.

H. Chemical Waste

1. Hazardous Waste Storage
   - All waste must be segregated into categories and stored to prevent incompatible mixtures within or among individual containers.
   - Waste must be kept in leak-proof containers with adequate secondary containment in case of breakage or spillage.
   - Waste storage area must be inspected at least weekly.
   - All waste containers must be labeled as required by UC Davis - Hazardous Waste Management Program.
2. Disposal of Hazardous Waste
   Hazardous waste, whether chemical, radioactive or biohazardous, should be labeled and disposed of in accordance with UC Davis - Hazardous Waste Management Program. Hazardous waste labels and pickup requests can be made through the UCD WASTe system: https://safetyservices.ucdavis.edu/units/ehs/hazardous-materials-management/waste-tracking Call EH&S (530-752-1493) for further information or assistance.

Chemical Safety: Ten Basic Rules

1. Know the hazards of chemicals in use.
2. Label all chemicals & their waste properly.
3. Use PPE while handling hazardous chemicals.
4. Work with volatile & hazardous chemicals in a fume hood.
5. Store flammables properly.
6. Do not work alone with hazardous chemicals.
7. Maintain clear access to exits, showers & eyewashes
8. Keep work areas free to clutter.
9. Wash promptly when chemical contacts skin.
10. Do not eat, drink, and apply cosmetics in lab.