

UTAH VALLEY UNIVERSITY
COLLEGE OF SCIENCE & HEALTH
Laboratory Safety Manual
December 2013

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I INTRODUCTION

Utah Valley University (UVU) Department of Chemistry is committed to providing a safe laboratory environment for its faculty, staff, students and visitors. The goal of the Laboratory Safety Program is to minimize the risk of injury or illness to laboratory workers by ensuring that they have the training, information, support and equipment needed to work safely in the laboratory.

The three basic elements of the Laboratory Safety Program are:

1. The departmental safety program led by the Chemical Hygiene Coordinator.
2. Laboratory safety support and training by the Chemical Hygiene Coordinator.
3. Instruction and oversight by an individual's Faculty/Laboratory Manager.

All laboratory workers, including faculty, staff and research students, are required to attend Laboratory Safety Training given by Chemical Hygiene Coordinator. This training gives an overview of general laboratory safety principles, references and resources for more specific safety information, and details about several support programs, such as the hazardous waste disposal program. The training supplements instruction given by Faculty/Laboratory Managers regarding safe work practices for specific chemicals and equipment.

Safety Policy

The Department of Chemistry is committed to providing employees with a safe and healthful workplace. It is our policy that employees report unsafe conditions and do not perform work tasks if the work is considered unsafe. Employees must report all accidents, injuries, and unsafe conditions to their supervisors.

All faculty, Laboratory Managers, staff, and students are encouraged to give recommendations to improve safety and health conditions. The Dean and Department chair will give true attention to and provide the financial resources for the correction of unsafe conditions. They will promote and influence safe behavior. This will be accomplished by both positive reinforcement of correct and safe activity, and by disciplinary action for those who willfully or repeatedly work in an unsafe manner.

This policy statement serves to express the department's commitment to and involvement in providing our employees a safe and healthy workplace. This workplace safety and health program will be incorporated as the standard of practice for the Department of Chemistry. Compliance with these safe practices and those of any regulatory agency will be required of all employees as a condition of continued employment.

This Laboratory Safety Manual is a companion to the Chemical Hygiene Plan (CHP) and both documents will be made readily available to all personnel and both should be read and studied carefully.

II ROLLS AND RESPONSIBILITIES

Deans and Department Chairs

- Ensure that safety is adequately budgeted for the department, job, etc.
- Communicate safe work practices regularly within the department.
- Attend departmental and university-wide safety meetings.
- Formally recognize outstanding safety performance by any/all personnel.
- Assist the Faculty / Lab Manager or any other personnel with the safety process as needed or as requested. This can include formal worksite periodic inspections.
- Uphold and enforce all known safe work practices.

Chemical Hygiene Coordinator

- Establish and implement a Chemical Hygiene Plan.
- Review and update the Chemical Hygiene Plan at least annually.
- Investigate accidents and chemical exposures within the department.
- Act as a liaison between the department and UVU Risk Management for laboratory safety issues.
- Maintain records of training, exposure monitoring and medical examinations.
- Ensure laboratory workers receive chemical and procedure-specific training.
- Review and approve use of particularly hazardous substances.
- Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices,
- Monitor procurement and use of chemicals in the lab, including determining that facilities and training levels are adequate for the chemicals in use,
- Perform regular, formal chemical hygiene and housekeeping inspections including inspections of emergency equipment,
- Help faculty and lab managers develop precautions and adequate facilities,
- Maintain current knowledge concerning the legal requirements of regulated substances in the laboratory,
- Maintain overall responsibility for the laboratory operation,
- Ensure that workers know and follow the chemical hygiene rules,
- Determine the proper level of personal protective equipment, ensure that such protective equipment is available and in working order,
- Monitor the waste disposal program

Faculty / Lab Managers

- Ensure new-hire orientation is given to new employees, or is followed up at the work level
- Ensure employees and students are given training that includes safe work practices on equipment, tools, machines, processes, etc.
- Personally conduct--or designate a qualified personnel to conduct-- regular inspections of the workplace
- Conduct frequent (daily) work discussions prior to the start of work that include safe work practices
- Uphold and enforce safe work practices. This includes influencing safe behavior by positive reinforcement such as recognition of worker's safe work performance, and/or monetary or gift awards for safe behavior. Enforcement action can also influence safe behavior when applied towards workers who blatantly perform unsafe acts, or who continually perform in an unsafe manner
- Investigate all incidents and take immediate corrective action to prevent re-occurrence
- Provide safety meetings on a regular basis and require attendance of all students

All Employees and Students

- Are to follow safe work practices, and if they are unsure of what is the correct/safe way to perform a task or a job, they are to ask their instructor, lab manager, or teaching assistant
- Must immediately report all unsafe equipment or tools to their instructor, lab manager, or immediate supervisor or manager. This includes reporting unsafe behavior of other workers, if these workers are approached and remain unwilling to correct their unsafe actions or conditions.
- Are to uphold the safe work practices this chemistry department has established
- If injured on the job, or become ill, immediately inform their supervisor or chair.

III EVACUATIONS PROCEDURES

Evacuation routes are posted in each work area. It is each individual's responsibly to make him/herself aware of the primary and secondary evacuation route. Depending on the reason for evacuation the following guidelines should be used.

Fire

In the event of a fire, depending on the size of the fire take the following actions:

If the fire is large or spreading.

- Activate the fire alarm to alert building occupants.
- If possible, shut down any equipment which may add fuel to the fire.

- Do not turn off any hoods in the immediate area, as they will tend to keep the area free from smoke and fumes.
- Close the door behind you to prevent the fire's spread.
- Evacuate the building.
- Be prepared to inform first responders the exact location, details of the fire, and the chemicals stored and used in the area.

If your clothing catches on fire. Drop to the floor and roll to smother the fire. If a co-worker's clothing catches fire, get the person to the floor and roll him or her to smother the flames. Use a safety shower immediately thereafter.

Small Fire. If the fire is not bigger than a wastepaper basket and you know how to use fire extinguisher and feel comfortable do so, fight the fire from a position where you can escape, only if you are confident that you will be successful.

Fire contained in a small vessel. If you feel comfortable in doing so, suffocate the fire by covering the vessel with a lid of some sort.

In all cases notify the Chemical Hygiene Coordinator so an incident report can be fill out.

Electrical Outage

In the event of a power outage take the following actions:

- Turn off power switches to any electrical equipment being used (except the hoods).
- Remove any container off hot/stir plates.
- Cover any open containers containing chemicals.
- If a container cannot be covered put the container in the hood and close the sash completely.
- Evacuate the room.
- Inform UVU Facilities of the outage.

These same procedure should be used for whatever other reason the laboratory may need to be evacuated.

Critical Operations

A critical operations is a procedure/operation that may have to be completed before he/she can evacuate the laboratory. In order for a procedure/operation to be deemed as "critical" it has to be a procedure/operation that if not completed could result a catastrophic results (i.e. fire, explosion). All Laboratory Managers, faculty and staff should identify any procedures that they would deem as critical (based on the definition

above) and will need to be approved by the Chemical Hygiene Coordinator and Department head. The CHP has the specifics of how this get approved.

Only those operations/procedures that have been pre-approved as “Critical” by the Chemical Hygiene Coordinator and the Department Head may be performed when evacuation is required.

IV HEALTH HAZARDS OF CHEMICALS

The decisions one makes concerning the use of chemicals in the laboratory should be based on an objective analysis of the hazards, rather than merely the perception of the risks involved. Once this has been accomplished, a reasonable means of controlling the hazards through experimental protocol, work practices, ventilation, use of protective clothing, etc., can be determined.

In order to assess the hazards of a particular chemical, both the physical and health hazards of the chemical must be considered.

Before using any chemical, the safety data sheet (SDS) or other appropriate resource should be reviewed to determine what conditions of use might pose a hazard. Accidents with hazardous chemicals can happen quickly and may be quite severe. The key to prevention of these accidents is awareness. Once the hazards are known, the risk of an accident may be reduced significantly by using safe work practices.

Toxic Effects of Chemical Exposure

There are several things to consider when discussing the toxic effects of chemical exposure

- **Dose** – How much of the chemical were you exposed to.
- **Exposure** – How long were you exposed to the chemical.
- **Local** – The injury involves the area of the body that was exposed to the chemical.
- **Systemic** – Tissues or organs unrelated to the exposure site are affected.
- **Acute** – Effect result from a single, short exposure. The effects usually appear quickly and are often reversible.
- **Chronic** – Toxicity results from repeated exposure of a long period of time.

All of these are address on the SDS.

Routes of Entry

There are basically four ways for chemicals to enter the body.

1. **Absorption** – The simplest way for chemicals to enter the body is through direct contact with the skin or eyes.

Skin contact with a chemical may result in a local reaction, such as a burn or rash, or absorption into the bloodstream. Absorption into the bloodstream may then allow the chemical to cause toxic effects on other parts of the body. The SDS usually includes information regarding whether or not skin absorption is a significant route of exposure.

Prevention: Wearing gloves, long sleeve shirts, long pants, and closed toe shoes are the best way to minimize skin exposure.

Symptoms of skin exposure: dry, whitened skin, redness and swelling, rashes or blisters, and itching

Treatment. In the event of chemical contact on skin, rinse the affected area with water for at least 15 minutes, removing clothing while rinsing, if necessary (**this is not a time to think about modesty!**) using the drench hose or safety shower. Seek medical attention if symptoms persist.

There are few chemicals that are exceptions to this rule and anyone using those chemicals will be informed.

Chemical contact with eyes can be particularly dangerous, resulting in painful injury or loss of sight.

Prevention: Wearing safety glasses, goggles, and face shields.

Symptoms of exposure: Major eye burning/itching, redness, extreme tear production.

Treatment: Immediately flush eye(s) with water for at least fifteen minutes. The eyes must be forcibly held open to wash, and the eyeballs must be rotated so all surface area is rinsed. The use of an eye wash fountain is desirable so hands are free to hold the eyes open. If an eyewash is not available, pour water on the eye, rinsing from the nose outward to avoid contamination of the unaffected eye. Remove contact lenses while rinsing (**Do not lose time removing contact lenses before rinsing!**). Do not attempt to rinse and reinsert contact lenses. Seek medical attention.

2. **Inhalation** - The respiratory tract is the most common route of entry for gases, vapors, particles, and aerosols (smoke, mists and fumes). These materials may be transported into the lungs and exert localized effects, or be absorbed into the bloodstream.

Most chemicals have an odor that is perceptible at a certain concentration, referred to as the odor threshold; however, there is no relationship between odor and toxicity.

Prevention: Working in a fume hood when using volatile chemicals, and wearing a respirator if necessary.

Symptoms of exposure: headaches, increased mucus production, and eye, nose and throat irritation. Narcotic effects, including confusion, dizziness, drowsiness

Treatment: Close containers, open windows or otherwise increase ventilation, and move to fresh air. If symptoms, such as headaches, nose or throat irritation, dizziness, or drowsiness persist, seek medical attention.

3. **Ingestion** – Although direct ingestion of a laboratory chemical is unlikely, exposure may occur as a result of ingesting contaminated food or beverages, touching the mouth with contaminated fingers, or swallowing inhaled particles which have been cleared from the respiratory system.

Prevention: Washing hands thoroughly after working with chemicals, even when gloves were worn. No eating or drinking in the laboratory. No mouth pipetting (**a major NO NO!**).

Symptoms of exposure: Nausea

Treatment: Call the Poison Control Center. Do not induce vomiting unless directed to do so.

4. **Injection** - Injection may occur through mishaps with syringe needles, when handling animals, or through accidents with pipettes, broken glassware or other sharp objects that have been contaminated with toxic substances.

Prevention: Using extreme care with using syringes and disposing of sharps appropriately. Always sweep up broken glass; never pick it up with your hands (even if they are gloved).

Symptoms of exposure: Nausea, dizziness, bleeding

Treatment: wash the area with soap and water and seek medical attention, if necessary.

V CONTROLLING CHEMICAL EXPOSURE

There are four general methods for controlling one's exposure to hazardous substances:

1. Engineering Controls
2. Administrative Controls
3. Safe Work Practices
4. Personal Protective Equipment (PPE)

In the laboratory, these methods or a combination of them can be used to keep exposure below permissible exposure limits.

Engineering Controls

Equipment installed in the laboratory should be considered the primary method of controlling chemical exposure. Examples of Engineering controls are:

- Fume Hoods
- Elephant Trunks
- Canopy Hoods
- Glove Boxes
- Sharp Containers
- Use of wet methods to reduce generation of dusts or other particulates
- General dilution ventilations

All laboratory personnel should be familiar enough with the chemicals they are using to know what equipment should be used to prevent chemical exposure. The SDS will have what engineered controls should be used when working with a specific chemical. The CHP has a much more detailed discussion on engineered controls.

Administrative Controls

Administrative controls are changes in the method or process to reduce exposure. These include:

- Substituting a less toxic chemical
- Reducing the amount of the chemical being used
- Reducing the length of the exposure time
- Using plastic equipment instead of glass

All Laboratory personnel are encouraged to look for and suggest changes in procedures to reduce exposure.

Safe Work Practices

Safe work practices are discussed in Section VI of this document.

Personal Protective Equipment (PPE)

Person protective equipment is discussed in Section VII of this document.

VI SAFE WORK PRACTICES

This section discusses general safe work practices that all laboratory personnel should consider as they work in any laboratory. The CHP discusses in detail the safe work practices that should be used for specific types of chemicals.

Before you Begin

All laboratory personnel should observe the following rules:

1. Know the potential hazards and appropriate safety precautions before beginning work. Ask and be able to answer the following questions:
 - What are the hazards?
 - What are the worst things that could happen?
 - What do I need to do to be prepared?
 - What work practices, facilities or personal protective equipment are needed to minimize the risk?
2. Know the location and how to use emergency equipment, including safety showers and eyewash stations.
3. Never block safety equipment or doors and keep aisles clear and free from tripping hazards.
4. Familiarize yourself with the emergency response procedures, facility alarms and building evacuation routes.
5. Know the types of personal protective equipment available and how to use them for each procedure.
6. Be alert to unsafe conditions and actions and bring them to the attention of your supervisor or lab manager immediately so that corrections can be made as soon as possible.
7. Prevent pollution by following waste disposal procedures. Chemical reactions may require traps or scrubbing devices to prevent the release of toxic substances to the laboratory or to the environment.
8. Position and clamp reaction apparatus thoughtfully in order to permit manipulation without the need to move the apparatus until the entire reaction is completed. Combine reagents in the appropriate order and avoid adding solids to hot liquids.

Chemical Storage

In general, store materials and equipment in cabinets and on shelving provided for such storage.

1. Avoid storing materials and equipment on top of cabinets
2. Be sure that the weight of the chemicals does not exceed the load capacity of the shelf or cabinet.

3. Wall-mounted shelving must have heavy-duty brackets and standards. This type of shelving is not recommended for chemical storage.
4. Cabinets for chemical storage must be of solid, sturdy construction, preferably hardwood or metal.
5. Do not store corrosive liquids above eye level.
6. Provide a specific storage location for each type of chemical, and return the chemicals to those locations after each use.
7. Avoid storing chemicals in the workspace within a laboratory hood, except for those chemicals currently in use.
8. If a chemical does not require a ventilated cabinet, store it inside a closable cabinet or on a shelf that has a lip to prevent containers from sliding off in the event of an accident or fire.
9. Do not expose chemicals to heat or direct sunlight.
10. Observe all precautions regarding the storage of incompatible chemicals.
11. Use corrosion resistant storage trays or secondary containers to collect materials if the primary container breaks or leaks.
12. Distinguish between refrigerators used for chemical storage and refrigerators used for food storage. Each refrigerator should be labeled "No Food" or "Food Only".
13. Do not store flammable liquids in a refrigerator unless it is approved for such storage. Such refrigerators are designed with non-sparking components to avoid an explosion.
14. Chemical storage cabinets located outside the laboratory (e.g., in hallways) should be labeled with the name of the laboratory group that owns and uses it.

Segregation of Chemicals

Incompatible chemicals should not be stored together. Storing chemicals alphabetically, without regard to compatibility, can increase the risk of a hazardous reaction, especially in the event of container breakage.

Use common sense when setting up chemical storage. Segregation that disrupts normal workflow can increase the potential for spills.

In general, dry reagents, liquids and compressed gases should be stored separately, then by hazard class, then alphabetically (if desired).

Segregate dry reagents as follows:

- Oxidizing salts
- Flammable solids
- Water-reactive solids
- All other solids

Segregate liquids as follows:

- Acids
- Separate mineral acids (hydrochloric, sulfuric) from organic acids (picric, acetic)
- Bases
- Oxidizers
- Perchlorates
- Flammable or combustible liquids
- All other liquids

Segregate compressed gases as follows:

- Toxic gases
- Flammable gases
- Oxidizing and inert gases

The CHP discusses at length how to store specific classes of chemicals and chemical incompatibility.

Personal Behavior

Professional standards of personal behavior are required in any laboratory:

1. Avoid distracting or startling other workers
2. Do not allow practical jokes or horseplay
3. Use laboratory equipment only for its designated purpose
4. Do not allow visitors, including children and pets, in laboratories where hazardous substances are stored or are in use or hazardous activities are in progress.
5. Do not prepare, store (even temporarily), or consume food or beverages in any chemical laboratory
6. Do not smoke in any chemical laboratory. Additionally, be aware that tobacco products in opened packages can absorb chemical vapors.
7. Do not apply cosmetics when in the laboratory
8. Never wear or bring lab coats or jackets into areas where food is consumed.
9. Confine long hair and loose clothing in the laboratory. Wear shoes at all times. Open-toed shoes or sandals are not appropriate.
10. Under no circumstances should mouth suction be used to pipette chemicals or to start a siphon. Use a pipette bulb or a mechanical pipetting device to provide a vacuum.
11. Wash well before leaving the laboratory. Do not use solvents for washing skin.
12. Keep work areas clean and free from obstruction. Clean up spills immediately.

13. Do not block access to exits, emergency equipment, controls, electrical panels etc.
14. Avoid working alone.

Transporting Chemicals

Spills and chemical exposure can occur if chemicals are transported incorrectly, even when moving chemicals from one part of the laboratory to another. To avoid these type of incidents, consider the following:

1. Use a bottle carrier, cart or other secondary container when transporting chemicals in breakable containers (especially 250 ml or more) through hallways or between buildings. Secondary containers are made of rubber, metal or plastic, with carrying handle(s), and are large enough to hold the entire contents of the chemical containers in the event of breakage. A variety of such containers are available from the Chemistry stockroom or from laboratory supply catalogs.
2. Transport of hazardous chemicals in individual containers exceeding four liters between buildings is strongly discouraged.
3. Transportation of hazardous chemicals in personal vehicles is strictly forbidden.
4. When moving in the laboratory, anticipate sudden backing up or changes in direction by others. If you should stumble or fall while carrying glassware or chemicals, try to project them away from yourself and others.
5. The individual transporting the chemical should be knowledgeable about the hazards of the chemical and should know how to handle a spill of the material.
6. When transporting compressed gas cylinders, the cylinder should always be strapped in a cylinder cart and the valve protected with a cover cap. Do not attempt to carry or roll cylinders from one area to another.
7. Transport chemicals in freight elevators rather than passenger elevators, if available.
8. Keep chemicals in their original packing when transporting, if possible.

Working with Scaled-Up Reactions

Scale-up of reactions from those producing a few milligrams or grams to those producing more than 100g of a product may represent several orders of magnitude of added risk. The attitudes, procedures and controls applicable to large-scale laboratory reactions are fundamentally the same as those for smaller-scale procedures. However, differences in heat transfer, stirring effects, times for dissolution, and effects of concentration and the fact that substantial amounts of materials are being used introduce the need for special vigilance for scaled-up work. Careful planning and consultation with experienced workers to prepare for any eventuality are essential for large-scale laboratory work.

Unattended Experiments

Laboratory operations involving hazardous substances are sometimes carried out continuously or overnight with no one present. It is the responsibility of the worker to design these experiments so as to prevent the release of hazardous substances in the event of interruptions in utility services such as electricity, cooling water, and inert gas.

1. Laboratory lights should be left on, and signs should be posted identifying the nature of the experiment and the hazardous substances in use.
2. If appropriate, arrangements should be made for other workers to periodically inspect the operation.
3. Carefully examine how chemicals and apparatus are stored, considering the possibility for fire, explosion or unintended reactions.

Working Alone

Individuals using hazardous chemicals should not work alone. Another individual capable of coming to the aid of the worker should be in visual or audio contact.

1. If working alone is absolutely necessary, the worker should have a phone immediately available and should be in contact with another person (who knows that he or she is being relied upon) at least every 30 minutes.
2. If no one from the laboratory is available, the worker should coordinate with another person in the building to check in on them periodically.
3. If the research or operation is particularly hazardous such that a researcher could be severely injured or overcome by the process, a capable person must be present at all times and know to contact Public Safety.

The Laboratory Manager, faculty, and staff are responsible for determining whether the work requires special precautions, such as having two people in the same room for particular operations.

VII PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal protective equipment (PPE) is special gear used to protect the wearer from specific hazards of a hazardous substance. It is a last resort protection system, to be used when substitution or engineering controls are not feasible. PPE does not reduce or eliminate the hazard, protects only the wearer, and does not protect anyone else.

PPE includes eye protection, gloves, respiratory protection, and protective clothing. The need for PPE is dependent upon the type of operations and the nature and quantity of the materials in use, and must be assessed on a case by case basis. Workers who rely on PPE must understand the functioning, proper use, and limitations of the PPE used.

Eye Protection

Safety Glasses

Safety glasses look very much like normal glasses but have lenses that are impact resistant and frames that are far stronger than standard street wear glasses. Safety glasses with proper impact and shatter resistance will be marked "Z87" on the frame or lens. Safety glasses must have side shields and should be worn whenever there is the possibility of objects striking the eye, such as particles, glass, or metal shards.

Standard street wear eyeglasses fitted with side shields are not sufficient. Safety glasses come in a variety of styles to provide the best fit and comfort, including some designed to fit over prescription glasses.

Safety glasses do not provide adequate protection from significant chemical splashes. They do not seal to the face, resulting in gaps at the top, bottom and sides, where chemicals may seep through. Safety glasses may be adequate when the potential splash is minimal.

Safety glasses are also not appropriate for dusts and powders, which can get by the glasses in ways similar to those described above. Safety goggles are best used for this type of potential exposure.

Chemical Splash Goggles

Chemical Splash Goggles should be worn when there is potential for splash from a hazardous material. Like safety glasses, goggles are impact resistant. Chemical splash goggles should have indirect ventilation so hazardous substances cannot drain into the eye area. Some may be worn over prescription glasses.

Face Shields

Face shields are in order when working with large volumes of hazardous materials, either for protection from splash to the face or flying particles. Face shields must be used in conjunction with safety glasses or goggles.

Contact Lenses

Contact lenses may be worn in the laboratory, but do not offer any protection from chemical contact. If a contact lens becomes contaminated with a hazardous chemical, rinse the eye(s) using an eyewash and remove the lens immediately. Contact lenses that have been contaminated with a chemical must be discarded. Safety glasses, goggles, and/or shield must still be worn.

Gloves

Choosing the appropriate hand protection can be a challenge in a laboratory setting. Considering the fact that dermatitis or inflammation of the skin accounts for 40-45% of all work-related diseases, selecting the right glove for the job is important.

Not only can many chemicals cause skin irritation or burns, but also absorption through the skin can be a significant route of exposure to certain chemicals. Dimethyl sulfoxide (DMSO), nitrobenzene, and many solvents are examples of chemicals that can be readily absorbed through the skin into the bloodstream, where the chemical may cause harmful effects.

Protective gloves should be worn when handling hazardous materials, chemicals of unknown toxicity, corrosive materials, rough or sharp-edged objects, and very hot or very cold materials. When handling chemicals in a laboratory, disposable latex, vinyl or nitrile examination gloves are usually appropriate for most circumstances. These gloves will offer protection from incidental splashes or contact.

When working with chemicals with high acute toxicity, working with corrosives in high concentrations, handling chemicals for extended periods of time or immersing all or part of a hand into a chemical, the appropriate glove material should be selected, based on chemical compatibility.

When selecting the appropriate glove, the following characteristics should be considered:

- degradation rating
- breakthrough time
- permeation rate

Degradation is the change in one or more of the physical properties of a glove caused by contact with a chemical. Degradation typically appears as hardening, stiffening, swelling, shrinking, or cracking of the glove. Degradation ratings indicate how well a glove will hold up when exposed to a chemical. When looking at a chemical compatibility chart, degradation is usually reported as E (excellent), G (good), F (fair), P (poor), NR (not recommended) or NT (not tested).

Breakthrough time is the elapsed time between the initial contact of the test chemical on the surface of the glove and the analytical detection of the chemical on the inside of the glove.

Permeation rate is the rate at which the test chemical passes through the glove material once breakthrough has occurred and equilibrium is reached. Permeation involves absorption of the chemical on the surface of the glove, diffusion through the glove, and desorption of the chemical on the inside of the glove. Resistance to

permeation rate is usually reported as E (excellent), G (good), F (fair), P (poor) or NR (not recommended). If chemical breakthrough does not occur, then permeation rate is not measured and is reported ND (none detected).

For mixtures, it is recommended that the glove material be selected based on the shortest breakthrough time.

The CHP discusses which glove is best for specific chemicals.

All gloves should be inspected for signs of degradation or puncture before use. Test for pinholes by blowing or trapping air inside and rolling them out. Do not fill them with water, as this makes the gloves uncomfortable and may make it more difficult to detect a leak when wearing the glove.

Disposable gloves should be changed when there is any sign of contamination. Reusable gloves should be washed frequently if used for an extended period of time.

While wearing gloves, be careful not to handle anything but the materials involved in the procedure. Touching equipment, phones, wastebaskets or other surfaces may cause contamination. Be aware of touching the face, hair, and clothing as well.

Before removing them, wash the outside of the glove. To avoid accidental skin exposure, remove the first glove by grasping the cuff and peeling the glove off the hand so that the glove is inside out. Repeat this process with the second hand, touching the inside of the glove cuff, rather than the outside. Wash hands immediately with soap and water.

Follow the manufacturer's instructions for washing and caring for reusable gloves.

Gloves should be removed avoiding skin contact with the exterior of the glove and possible contamination. Disposable gloves should be removed as follows:

1. Grasp the exterior of one glove with your other gloved hand.
2. Carefully pull the glove off your hand, turning it inside-out. The contamination is now on the inside.
3. Ball the glove up and hold in your other gloved hand.
4. Slide your ungloved finger into the opening of the other glove. Avoid touching the exterior.
5. Carefully pull the glove off your hand, turning it inside out again. All contamination is contained.
6. Discard appropriately.

Respiratory Protection

A respirator may only be used when engineering controls, such as general ventilation or a fume hood, are not feasible or do not reduce the exposure of a chemical to acceptable

levels. Since the use of a respirator is regulated by the OSHA Respiratory Protection Standard, respirator use at UVU is subject to prior review by the Chemical Hygiene Coordinator according to university policy.

Any worker who believes that respiratory protection is needed must notify the Chemical Hygiene Coordinator for evaluation of the hazard and enrollment in the Respiratory Protection Program. This program involves procedures for respirator selection, medical assessment of employee health, employee training, proper fitting, respirator inspection and maintenance, and recordkeeping.

Protective Clothing

When the possibility of chemical contamination exists, protective clothing that resists physical and chemical hazards should be worn over street clothes. Lab coats are appropriate for minor chemical splashes and solids contamination, while plastic or rubber aprons are best for protection from corrosive or irritating liquids. Disposable outer garments (i.e., Tyvek suits) may be useful when cleaning and decontamination of reusable clothing is difficult.

Loose clothing (such as overlarge lab coats or ties), skimpy clothing (such as shorts), torn clothing and unrestrained hair may pose a hazard in the laboratory.

Footwear

Closed-toed shoes should be worn at all times in buildings where chemicals are stored or used. Perforated shoes, sandals or cloth sneakers should not be worn in laboratories or where mechanical work is conducted. Such shoes offer no barrier between the laboratory worker and chemicals or broken glass.

Chemical resistant overshoes or boots may be used to avoid possible exposure to corrosive chemical or large quantities of solvents or water that might penetrate normal footwear (e.g., during spill cleanup).

VIII CHEMICAL SPILLS

Most spills are preventable. The following are some tips that could help to prevent or minimize the magnitude of a spill:

- Pre-planning is essential. Before working with a chemical, the laboratory worker should know how to proceed with spill cleanup and should ensure that there are adequate spill control materials available.
- Place chemical containers being used in a hood or lab bench area that reduces the possibility of accidentally knocking over a container.
- Keep all unused reagents in their appropriate storage area and keep your work area clean of needles equipment and clutter.

- Plan your movements. Look where you are reaching to ensure you will not cause a spill.
- Avoid transporting chemicals from the stockroom during periods of high traffic in the hallways such as between classes.
- Transport chemical containers in a chemical carrier or cart.
- Place absorbent plastic backed liners on bench tops or in fume hoods where spills can be anticipated. For volumes of liquid larger than what can be absorbed by liners, use trays.

Spill Response and Clean-up Procedures

In the event of a chemical spill, the individual(s) who caused the spill is responsible for prompt and proper clean-up. It is also their responsibility to have spill control and personal protective equipment appropriate for the chemicals being handled readily available.

The following are general guidelines to be followed for a chemical spill. More detailed procedures are available in the CHP.

1. Immediately alert area occupants and supervisor, and evacuate the area, if necessary.
2. If there is a fire or medical attention is needed, contact Public Safety at 911.
3. Attend to any people who may be contaminated. Contaminated clothing must be removed immediately and the skin flushed with water for no less than fifteen minutes.
4. If a volatile, flammable material is spilled, immediately warn everyone, control sources of ignition and ventilate the area.
5. Don personal protective equipment, as appropriate to the hazards. Refer to the Material Safety Data Sheet or other references for information.
6. Consider the need for respiratory protection. The use of a respirator or self-contained breathing apparatus requires specialized training and medical surveillance. Never enter a contaminated atmosphere without protection or use a respirator without training. If respiratory protection is used, be sure there is another person outside the spill area in communication, in case of an emergency. If no one is available, contact Public Safety.
7. Using the chart below, determine the extent and type of spill. If the spill is large, if there has been a release to the environment or if there is no one knowledgeable about spill clean-up available, contact the Chemical Hygiene Coordinator or Public Safety at 911.

Category	Size	Response	Treatment Materials
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Small	up to 300cc	chemical treatment or absorption	neutralization or absorption spill kit
Medium	300 cc - 5 liters	absorption	absorption spill kit
Large	more than 5 liters	call public safety	outside help

8. Protect floor drains or other means for environmental release. Spill socks and absorbents may be placed around drains, as needed.
9. Contain and clean-up the spill according to the table above.
Loose spill control materials should be distributed over the entire spill area, working from the outside, circling to the inside. This reduces the chance of splash or spread of the spilled chemical. Many neutralizers for acids or bases have a color change indicator to show when neutralization is complete.
10. When spilled materials have been absorbed, use brush and scoop to place materials in an appropriate container. Polyethylene bags may be used for small spills. Five gallon pails or 20 gallon drums with polyethylene liners may be appropriate for larger quantities.
11. Complete a hazardous waste sticker, identifying the material as Spill Debris involving XYZ Chemical, and affix onto the container. Spill control materials will probably need to be disposed of as hazardous waste.
12. Decontaminate the surface where the spill occurred using a mild detergent and water, when appropriate.
13. Report all spills to your Laboratory Manager/Faculty Supervisor and the Chemical Hygiene Coordinator.

IX WASTE DISPOSAL

Refer to the CHP for waste disposal procedures.