CHEMICAL HYGIENE PLAN

February 2014

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1.0 Objective

This Chemical Hygiene Plan establishes policies, procedures, and guidelines for the safe use and handling of chemicals in laboratories, and establishes a foundation for safe chemical handling in other work areas on campus. The goal is to create a safe work environment for Touro University's (TUC) laboratory employees, and which will also apply to students in TUC labs.

An important objective of this program is to enhance laboratory safety, therefore this Plan is intended to serve as a reference and a guidance document for employees working in TUC laboratories.

2.0 Regulatory Basis

This Plan complies with federal and state OSHA standards for laboratories, which are largely based on principles and safe lab practices established in a publication called ***Prudent Practices in the Laboratory***, among other references on lab safety. The principles of chemical safety presented in this Plan are based on guidelines and practices consistent across the research community.

OSHA Regulations include Occupational Exposure to Hazardous Chemicals in Laboratories presented in: *Title 8 California Code of Regulations, Section 5191*.

Though not specific to labs, the California Fire Code and the Building Codes establishes rules for storing hazardous chemicals.

3.0 Responsibilities

Employees are responsible for knowing the safe handling practices described in this document and expected to apply these practices and principles while working in the labs in order to support the safety of all employees and students in the laboratories. Therefore, every employee in TUC labs has a responsibility for safety in order to prevent themselves and others from risk of exposure or from accidents.

3.1 Principle Investigators

Principle Investigators (PIs) have a responsibility for the safety of direct reports and for employees working on their projects. California reinforces this concept with civil laws regarding workplace safety. These responsibilities are also discussed in TUCs Injury and Illness Prevention Plan (IIPP), all of which relate directly to holding supervisors and managers accountable for complying with safety policies, procedures, and guidelines. Among these responsibilities include:

- Providing direct reports with access and time to read this, and other applicable safety documents.
- Providing that direct reports attend the required training for this Plan.

- Complying with recommended corrective actions identified from inspections and self-assessments, as directed in the IIPP.

3.2 Chemical Hygiene Officer

Under the OSHA regulation the Chemical Hygiene Officer is responsible for administering this Plan. Currently TUC's Chemical Hygiene Officer is their acting Safety Consultant, Mr. Randy Cook.

The Chemical Hygiene Officer is the lead authority for chemical safety at TUC and is chosen because he or she is knowledgeable about this Plan and has the resources available to answer questions and address concerns related to the safe handling of chemicals. Other responsibilities include:

- Working with management, PIs, and lab staff to develop and implement chemical safety policies and procedures.
- Working with the University Safety Coordinator to improve and enhance lab safety and to resolve and respond to safety issues arising from lab inspections or from employee concerns and complaints.

When necessary, the Chemical Hygiene Officer may seek guidance from resources outside the company.

3.3 Employees

Employees are responsible for knowing the contents of this Plan and for adopting safe work practices as a primary consideration when performing any laboratory task or activity. Lab employees are responsible for the following:

- Planning and organizing tasks in a manner that allows time to implement the necessary safety provisions.
- Wearing appropriate personal protective equipment (PPE) while working in the lab.
- Maintaining a workstation that is free of contaminants, chemical residues, and provides adequate space to conduct experiments.
- Reporting injuries, accidents, and unsafe acts to one's supervisor or to the University Safety Officer. This is intended to help resolve hazardous or employees.
- Knowing the hazardous properties of the chemicals with which they work.
- Safely handling chemicals and referring to Material Safety Data Sheets (MSDS) if the risk of a chemical(s) is unknown.

4.0 Chemical Hygiene and Safety

This plan complies with the regulatory requirements and with commonly accepted safety guidelines and procedures that are consistent with industry standards for safe laboratory work practices.

The components of the TUC chemical safety program include the following.

- A written Chemical Hygiene Plan
- Appointing a Chemical Hygiene Officer
- Establishing methods for identifying hazards
- Establishing a system for evaluating employee exposure that honors OSHA regulations and other applicable occupational exposure limits
- Establishing methods for training and providing hazard information to employees
- Providing for medical consultation and surveillance, if necessary

4.1 Principles of Chemical Safety

TUC laboratories have a variety of hazardous chemicals, each having different hazardous properties. By virtue of the assorted hazards in a lab, employees are expected to be aware of the potential risks of the hazardous materials they handle in order to avoid compromising the safety of themselves and coworkers. It should also be noted that the synergistic effects of being exposed to even small amounts of multiple hazardous materials, and complacency with handling such agents, could present increased health risks over the course of a career.

The basic principles behind the safe use of chemicals are at the core of laboratory safety, and when adopted, form the basis of laboratory safety and establishes the standard by which all labs are expected to follow. These basic principles include the following.

4.1.1 Minimize Exposures to Hazardous Materials

Employees are expected to be considerate of the safety concerns of other employees in the lab.

- Know the hazards of the chemical! Employees are expected to become familiar with the physical and health hazards of all the chemicals they work with in order to take the proper precautions. Refer to the container label, the MSDS, or other hazard warning information that may be readily available. MSDSs are found in the hallways outside labs in Lander Hall and in the Library.
- Handle all volatile compounds in a chemical fume hood. Typically these compounds include organic solvents and inorganic acids. Proper use of

hoods prevents exposures to hazardous chemicals and reduces odors. Appendix C expands discusses the proper use of chemical exhaust hoods.

- Weigh toxic solid chemicals (e.g. powders, crystals, etc.) in an enclosed balance. Always weigh chemicals away from drafty areas or near fume hoods that ca disperse the materials to other surfaces.
- Substitute concentrated solutions with a dilution or concentration that you will need. This eliminates one step of diluting a concentrated chemical, thus reducing the potential for exposure.
- Always clean the work area surrounding a balance after using it. Wet a paper towel with 70% alcohol to absorb the contaminants and dispose of it as hazardous waste.
- Wear the appropriate personal protective equipment (PPE). This is discussed in more detail in Section 6.10.3.
- Maintain a clean and orderly workstation keeping only the supplies and chemicals needed for that experiment nearby. A cluttered workstation restricts movement, and is a leading contributor to laboratory spills and releases.
- Use absorbent bench paper to prevent contamination of lab surfaces and personal exposure. Dispose of bench coverings as hazardous waste when finished using it.

If there is any reason to believe that you or other employees may be at risk of exposure, contact your supervisor or Chemical Hygiene Officer for advice.

4.1.2 Avoid Underestimating the Risks of Chemicals

Many chemicals have more than one risk associated with them. For example, a hazardous material can have flammable properties, and also can be acutely toxic, or present other health risks. Just because you have avoided exposure from working with the material in the past, does not justify a nonchalant approach to handling it. Make sure that you check the following resources for further information.

- Read the label carefully and evaluate if the information adequately discusses the risks
- Check the MSDS for hazard information
- Check chemical safety resources on the Internet for specific chemicals

  Complacency with chemical handling can result in serious consequences if not paying attention to the inherent hazards of laboratory chemicals.

4.1.3 Provide Adequate Ventilation

Many laboratory activities involve handling chemicals at the lab bench; therefore laboratory ventilation is an important component in minimizing the accumulation of hazardous contaminants. Lab ventilation provides that fresh air is supplied as a percentage of the make-up air that is re-circulated through the general ventilation system. This means that a percentage of airborne chemicals produced in the labs will be re-circulated.

Since there is no guarantee of the ventilation rate of individual labs, employees are to control volatile chemicals and toxic materials in a fume hood. Employees are discouraged from handling volatile chemicals on the lab bench, where vapors can disperse through the building's ventilation system exposing employees in other parts of the building.

If ventilation is needed to support a new process it is the responsibility of the PI to contact Facilities before installing a new instrument or device. If specialized ventilation devices, such as exhaust canopies, snorkel exhaust units, or ventilated cabinets are recommended to control operations, then Facilities must support these upgrades. If it is not feasible to purchase or install a separate ventilation system like those mentioned above, then every effort should be made to conduct the experiment in a chemical exhaust hood.

4.2 Basic Rules for Safe Chemical Handling

Circumventing basic safety can jeopardize the health, safety, and welfare of all lab employees, therefore employees are expected to follow these practices.

- Purchase and use volumes of chemicals appropriate to the work being performed. There is limited lab storage, so by only what you need. Price breaks from vendors for large-volume purchases can cost more than it appears.
- Wash hands after removing gloves and before leaving the lab.
- Avoid complacency in handling common chemicals and lab reagents that can result in acute and chronic exposures.
- Eating and drinking in the labs is not permitted, and avoid carrying food and drinks through labs.
- Avoid all hand to face contact, such as applying cosmetics, lip balm, chew gum, or scratch your face. These activities can transfer contaminants to the face presenting an exposure pathway.
- Use only mechanical or electronic methods for pipetting or for suction, and do not perform mouth pipetting.
- Horseplay is not allowed in the labs, just as it is not permitted anywhere in the facility
- Children and pets are not allowed in the labs at any time

- Clean up accidents and spills immediately. Spill cleanup procedures are covered in Section 6.0.
- Avoid performing hazardous procedures or handling highly toxic materials, when working during off-business hours or on weekends. If working late or on weekends, inform the lab supervisor as a way of accounting for your presence in case of an emergency.

4.3 Chemical Procurement

Purchasing and ordering chemicals is the first stage in planning experiments. Understandably, some experiments require the use of extremely hazardous chemicals, so scientists are encouraged to consider a safer alternative to extremely hazardous agents, if available. Try substituting a less hazardous substance for one that is known to pose a high risk of exposure. For example, purchasing a diluted solution of hydrochloric acid as a substitute for a concentrated solution reduces the potential risk of exposure, thus requiring one to only dispensing the acid in the concentration needed.

Employees should try not to duplicate the purchase of chemicals already open and in use. Check the lab shelves and cabinets to determine if the chemical you need is available. This is important in keeping the inventory of hazardous chemicals under control and saves on unnecessary disposal costs in the future.

Employees are also instructed to purchase volumes of materials that they can realistically consume. Buying large quantities can result in the accumulation of hazardous materials that eventually take up useful space and become hazardous waste because they've been stored too long for the material to be useful.

Some materials can become unstable after a period of time, such as ethyl ether or hygroscopic (water-absorbing) chemicals, and require writing expiration dates on chemical containers at the time of delivery. These materials must be either consumed or disposed of by the expiration date. These chemicals can form explosive peroxides or create exposure risks stored for too long under relatively ambient storage conditions.

Knowing the hazardous properties of newly purchased materials is the first necessary precaution to handling it safely. Knowledge of a chemical's hazards before initiating an experiment also allows the user to set up a workstation to accommodate highly hazardous materials. Contact the PI or Chemical Hygiene Officer with any questions about the safe handling of specific chemicals.

4.4 Distribution and Transport

It is important that employees make every effort to prevent releases or spills of hazardous materials by confining chemical handling to portions of the building that are tiled and removed from administrative areas. Packages of chemical and biological materials must be delivered to the lab and not to employee's desks or offices. Scientists are expected to put hazardous materials away in an appropriate storage location as soon as possible after receipt. Flammable materials belong in a flammable storage cabinet, acids in a corrosives cabinet, etc.

To protect against accidental spills and releases, employees are instructed to use a cart constructed with a protective lip around the edge, or use a secondary container (pan, ice bucket, or tub) from the lab, to carry chemicals through hallways. Avoid transporting chemicals in high traffic public hallways and corridors.

Also avoid carrying packages that are so large they obstruct visibility, or packages that are heavy enough to warrant use of a cart. Carts are available in the main lab.

Compressed gas cylinders must be transported using the proper kind of dolly, and not manually rolled on its base when moving them into position.

4.5 Chemical Storage

The properties of hazardous chemicals, and compatibility with other chemical classes, are important factors in determining proper storage measures. For example, flammable and combustible chemicals are best suited for storage in an approved flammable storage cabinet. Similarly other hazard classes of chemicals must be stored in storage cabinets to prevent commingling with incompatible materials.

In all cases, storage locations must be labeled with the class of the material and a hazard-warning label.

Chemicals can be classified into six primary hazard classes, requiring separation from incompatible chemicals during storage.

4.5.1 Chemical Compatibility

This separation prevents the potential for commingling and producing toxic vapors, highly exothermic reactions, or the generation of highly toxic byproducts. Thus chemical compatibility is an important consideration in preventing chemical accidents from an earthquake.

Small amounts of incompatible stock solutions can safely be stored on the shelves above lab benches, if stored in secondary containment. The following are a few tips on separating incompatible chemicals.

- **Acids and bases**: These materials must be stored in separate acid and base cabinets. Safe storage of corrosive chemicals requires nonmetallic cabinetry, because these materials corrode metal and can eventually damage the storage cabinets and leave deposits of corrosive materials on the surfaces.

- **Flammables and oxidizers:** Most, if not all, organic liquids and solids are potential fuels for a fire. Store solvents away from oxidizing gases (e.g. oxygen gas), oxidizing liquids (e.g. hydrogen peroxide solutions, organic peroxides, nitric and sulfuric acids), and oxidizing solids (e.g. nitrates, perchlorates, metal salts, permanganates, molybdates, tungstates, and chromates).
- **Water-sensitive materials:** The moisture from the air can ignite these chemicals, so they should be stored in a cool, dry place, or in desiccators with a good seal on the lid to prevent from absorbing moisture.
- **Shock, light, or heat-sensitive materials:** Store such reagents and other reactive materials in cool, dry, dark places.

The following recommendations are intended to help employees store materials properly and safely.

- **Put chemicals away when finished using them.** Storing chemicals indefinitely on the bench increases the risk from accidents, earthquakes, and increase clutter.
  - Chemicals taken from the chemical storage shelves to one's bench must be returned at the end of the day or after use.
  - Stock solutions and chemical formulations used daily are best stored in secondary tubs or trays on the shelves at each lab bench.
- **Do not store chemicals in chemical exhaust hoods.** This space is intended for chemical handling, and if occupied with stored chemicals, equipment, and waste, the hood will not provide adequate room to work inside the hood, and will compromise its safety features.
- **Do not store dry chemicals alphabetically.** Highly toxic chemicals should be stored in containment trays and separated from other chemicals and labeled accordingly to ensure that employees are aware of the special hazards associated with these chemicals.

Make sure that all chemical storage locations have either a restraint, or lip on the edge of the shelf, or are stored in secondary containment to capture any spilled material.

If you are unsure of how to store chemicals properly, consult with the Chemical Hygiene Officer or your supervisor to help identify the best methods.

4.5.2 Chemical Storage Cabinets

The laboratory provides chemical storage cabinets underneath the chemical exhaust hoods and some benches. The main lab in Lander Hall has corrosive storage cabinets and flammable storage cabinets. Chemicals in the storage cabinets underneath the exhaust hoods are passively ventilated outside the building through the exhaust system.

Flammable storage cabinets are constructed of double-reinforced steel and are designed to prevent fire from contacting the stored contents, so it is important to keep the cabinets closed when not in use, and to purchase only enough flammable chemicals that can be safely stored in the lab.

Corrosive storage cabinets are constructed of nonreactive materials and if used to store volatile acids, such as hydrochloric acid, should be located in a well-ventilated part of the lab.

Avoid storing chemicals on the bench, using shelves and cabinets to store dry chemicals and stock solutions common to the lab. Good lab practices include putting all chemicals and formulations away after use thereby removing the risk of unwanted releases or accidents. Even a relatively small earthquake can send bottles and chemicals dispersed across the laboratory.

4.6 Controlling Workplace Contaminants

Safety professionals apply a three-tiered approach to the control of hazardous materials. This is based on controlling hazards and hazardous operations by using a hierarchical approach of one or more of the three control methods; engineering controls, administrative controls, and personal protection equipment (PPE).

Engineering Controls are at the top of the hierarchy and are defined as mechanical methods for controlling a contaminant at its source. If this method is not effective on its own, or is not feasible (such as installing an expensive control device), then other control methods may be employed to reduce risk and/ or the duration of exposure to a hazardous condition. Administrative controls are defined as procedures or work practices that reduce the duration of a task or reduce the repetitive motions associated with an operation. These are only effective when employees adopt the procedures and practices. When neither of these controls can completely prevent contaminants from posing a risk, then personal protective equipment is another option.

4.6.1 Engineering Controls

Engineering Controls includes ventilation and exhaust systems, such as fume hoods, exhaust devices, or even simple devices such as pipetters, which separate the human/ hazard interface. Engineering controls are more reliable in controlling contaminants and are therefore at the top of the control hierarchy.

As stated earlier, good ventilation is one of the key elements in preventing occupational exposures, because air movement prevents the accumulation of contaminants that intrinsically occur in labs.

Exhaust hoods in the main Lab in Lander Hall, are for conducting experiments and for dispensing and handling of volatile, flammable, and toxic agent. Because of this, it is important that employees refer to Appendix C to ensure that fume hoods are used properly so employees prevent exposure to themselves and others.

OSHA requirements for fume hoods include the following.

- All hoods must have a velocity meter or alarm device to ensure that the users know if the exhaust hood is not functioning properly. Never work at a hood that is in alarm or not functioning.
- Must be “certified” at least once a year by a third party to provide that the hood is functioning properly.
- Fume hood air handling systems are separate from the “house” system that serves other functions in the building.

Remote exhaust systems are useful for certain operations that cannot be conducted in a fume hood, because they prevent contaminants from escaping from their point of use. If installing such units, ensure that existing chemical exhaust systems are not compromised, and that a performance standard is established before installation. In cases where remote exhaust devices are connected into existing ductwork, there must be enough air velocity, measured in linear feet per minute, to effectively exhaust contaminants from all hoods.

4.6.2 Administrative Controls

Administrative Controls (a.k.a. Work Practice Controls) may be necessary to establish procedures or work practices specific to a process or experiment based on the inherent hazards, and to minimize the potential for exposure to employees, and which result in a reduction in the hazard potential of the operation. Examples of administrative controls include the following.

- Adopt storage and handling practices that prevent spills or exposures to hazardous materials
- Establish hazardous materials handling and storage locations that accommodate safe storage and handling practices
- Waste handling methods that prevent breathing uncontained vapors or contact with waste
- Safe transport of hazardous materials by using secondary containment or carts to prevent spills and accidents

- Preventive maintenance program
- Good housekeeping and uncluttered work stations
- Practicing good personal hygiene
- Establish effective and appropriate decontaminating procedures, depending on the materials being used
- Regular replacement of work surface coverings
- Storing liquids off of the floor, or in secondary containment if floor storage is necessary
- Using compatible storage and waste containers

Administrative controls are most effective when employees are trained in the procedures and incorporated as standard practice by all lab employees. New employees should also be trained in specific procedures or processes before being asked to perform a task or operation.

4.6.3 Personal Protective Equipment (PPE)

If either administrative or engineering controls, or both, are not adequate to completely protect employees from workplace contaminants, then PPE is issued. PPE is defined as attire or devices that are worn (such as respirators) that protect employees from contaminants. Under OSHA regulations, employees who are issued PPE must be trained in its proper application and use and instructed in how to maintain, repair, and safely store their equipment.

PPE captures droplets and small amounts of the chemicals that employees handle, and therefore must not be taken into administrative work areas, where they could potentially contaminate common areas and work surfaces, or potentially expose other employees. Standard laboratory attire includes the following.

4.6.3.1 Lab coats

TUC provides lab coats for lab employees, and has a policy requiring lab staff to wear lab coats when working in the laboratory. Lab coats are a primary barrier against chemical and biological contaminants. Cotton lab coats provide relative comfort while being able to absorb small spills and splashes. TUC employees are instructed to change lab coats after they are soiled, or within a few days to one week of regular use.

There are many types of alternative styles of lab attire, which include chemically impervious aprons, disposable sleeve covers, coveralls, lab coats with elastic cuffs or snaps instead of buttons, and a host of other attributes. The varying designs are intended for different types of work settings and provide options that encourage employees to wear protective attire.

Disposable lab coats are often used for dirty operations or for jobs that require frequent clothing changes for contamination control. If the standard lab coat is not effective for your intended application, talk to the Chemical Hygiene Officer or supervisor about other alternatives.

Never wear a lab coat into a food handling or food storage area. When a lab coat becomes soiled.

4.6.3.2 Safety Eyewear

The eyes are an exposure pathway, therefore lab employees working are expected to wear safety glasses to prevent against exposures. TUC offers safety glasses to lab employees and follows OSHA standards by requiring safety glasses to have side shields and brow guards included in the design, and to be protective of ultraviolet radiation, to protect against exposure to harmful UV rays.

Safety glasses are intended for working at the bench and handling relatively small quantities of hazardous chemicals. As the volume of chemicals increases, so should the level of eye and face protection. For example, standard lab safety glasses are fine for dispensing liquids from a 4 - liter bottle into a smaller container inside of a fume hood. If handling a larger volume of liquid, then it is appropriate to wear wrap-around safety goggles, which offer greater splash protection. A face shield is recommended while working with volumes of hazardous materials where a splash to the face is a distinct possibility, or if the material is highly corrosive.

Some basic rules for eye safety are presented below.

- Contact lenses are discouraged, because in an emergency it may become difficult to flush the eyes or remove the contacts before permanent eye damage occurs.
- Splash goggles should be worn when there is the chance of a chemical splash or spray. Operations requiring goggles include, but are not limited to, pouring, scrubbing, rinsing, spraying (aerosols), washing, and dispensing material that has a potential for causing harm, such as corrosive chemicals.
- Face shields protect the eyes, face, and neck from chemical splashes and spray as well as flying particles.
- Face shields must be used when handling cryogenic liquids to prevent exposures and cryogen burns.
- Always wear safety glasses when opening packages or packing containers with metal binding straps to prevent the straps from snapping and making contact with the eyes.

4.6.3.3 Gloves and Skin Covering

The type of glove material should be compatible with the material being handled. Nitrile gloves are the best glove material for chemical handling in a laboratory. Latex gloves are adequate for handling biological agents, though are not intended for use with chemicals because most solvents and many other lab reagents permeate latex gloves, which can contaminate the skin. The following are guidelines for the types of gloves commonly used in labs.

- Disposable gloves should be used for handling chemicals and biological agents under standard laboratory conditions. Specific chemicals may require a more protective glove material. Disposable gloves come in different lengths, thicknesses and styles, accommodating different needs in the lab.
- Neoprene is a glove material used for handling corrosive chemicals. These are usually thick and heavy and are intended for tasks that do not require a great deal of finger dexterity.
- Thermal gloves are made of thick fabric and asbestos to prevent against burns from hot objects.
- Cryogenic gloves are available for use with liquid nitrogen to protect employees from exposures to super cold fluids, since cryogenic liquids can cause serious skin burns and pose a potential risk of permanent skin damage.

It is important to provide greater hand protection as the volumes of hazardous materials increase. Use neoprene or thick nitrile gloves when dispensing or handling volumes of corrosive chemicals greater than 2.5 liters. When handling volumes of hazardous chemicals greater than this, use gloves that cover all exposed skin and are impervious to the materials being handled.

4.6.3.4 Respiratory Protection

Respiratory protection is used when engineering controls, such as fume hoods, are not available or adequate. If working in an uncontrolled setting, you must first determine the appropriate respirator for the types contaminants.

Note: A respirator should not be a substitute for using a fume hood, and is best used for operations where there is no engineering control available, AND where other employees are not present.

OSHA approves the use of N-95 respirators to control exposure to particulate contaminants, such as powders or other sold chemicals. These are disposable and can be used without special provisions.

N-95 Respirator

Use of air-purifying cartridge style respirators requires a formal Respiratory Protection program as regulated under Cal OSHA. This includes a physician-attended medial evaluation, a written plan, annual training, and is intended to ensure that employees know the proper application, and the limitations, for using respirators. In the lab environment, if hazardous vapors are present then other employees may be exposed. Look for alternative controls other than the respirator to prevent issuing respirators to all employees.

Half-mask Air-Purifying Respirator

4.6.3.5 Other PPE

Closed-topped shoes are also a part of standard lab attire, because sandals, clogs, and similar footwear expose skin and are not appropriate for working around hazardous materials. A drop of a corrosive material such as phenol, and any acid or base will cause skin burns.

Employees are cautioned to wear appropriate clothing for working in the lab. It is advisable that employees who want to dress casually, especially during warm-weather months, bring clothing to work that is appropriate for working in the lab. In general, you want to keep feet, legs, arms, and hands covered when working with hazardous materials.

Regardless of the quantities of chemicals being handled, all employees in the lab must wear the appropriate PPE for the task at hand. Equally as important, PPE must not be worn outside the laboratory areas.

4.7 Regulatory Limits For Chemicals

OSHA regulates the airborne concentrations for several hundred chemicals commonly used in the workplace. OSHA establishes what are called permissible exposure limits (PELs), which identify unsafe concentrations of these chemicals, above which require controls. The list of OSHA-regulated chemicals is provided in Title 8 CCR, Section 5155, Table AC1.

If concentrations of any of the regulated chemicals exceed the PEL, or are above the recommended limits, then control measures discussed in Section 4.6 must be implemented to lower the concentration, or move it to a controlled environment. Evaluate effective control measures before implementing any.

The following are three different categories of regulatory limits regulated by OSHA.

Time-Weighted Average (TWA) – This is the average concentration of a chemical, measured for an 8-hour workday, to which nearly all workers may be exposed, day after day and year after year, without suffering any adverse effects. Most of the regulated chemicals have a permissible exposure limit with a time-weighted average.

Short-term Exposure Limit (STEL) – This is the maximum concentration of a chemical to which an employee can be exposed continuously for up to 15 minutes without suffering adverse health effects.

Ceiling – The Ceiling Limit must not be exceeded at any time during the workday unless control measures are implemented. Some very hazardous chemicals have only a Ceiling limit.

Since there are synergistic effects from working with multiple chemicals that can change the risk from ambient chemical concentrations, it is necessary that employees understand the inherent properties of the chemicals they handle to ensure that all safety precautions are taken.

The only way to determine if workplace concentrations exceed these levels is to conduct exposure monitoring, using OSHA-approved protocols, to quantitatively measure the potential for exposure. This is also addressed below in Sections 4.8 and 4.12.

4.8 Environmental Monitoring

Employees are encouraged to report concerns of overexposure to chemicals to the work area supervisor or to the Chemical Hygiene Officer. Supervisors have a regulatory obligation to address employee's concerns and complaints, as indicated in the Injury Illness Prevention Plan. Such complaints or concerns may involve exposure monitoring to determine if the concentrations of hazardous chemicals exceed regulatory limits. The only way to evaluate workplace concentrations is to conduct industrial hygiene monitoring and sampling. The Chemical Hygiene Officer can arrange for monitoring and sampling, and analysis will reveal if a contaminant poses a risk. In the meantime, the operation must be controlled or curtailed until the results reveal the actual levels.

Qualitative measurements can be done in real time offering a snapshot of conditions and provide immediate results. These may not be sensitive enough for comparison to OSHA regulations, but provide useful data for further evaluation. Quantitative measurements are conducted over a period of the workday. Quantitative sampling is usually sent off for analysis, but provides a more accurate assessment of chemical concentrations in the workplace.

4.9 Housekeeping

Good housekeeping is an Administrative control and is the responsibility of every lab employee. Good housekeeping is also one of the most effective control methods for preventing spills and incidents. Cluttered and messy benches reduce the space that employees can effectively conduct experiments, therefore employees are instructed to maintain a clutter-free, uncontaminated workbench in the lab.

Housekeeping also has application with regard to seismic safety. Even though shelves in the lab have seismic restraints, a large enough tremor will cause bottles to fly off of shelves. As a seismic safety consideration, store chemicals and chemical formulations of all kinds on the lowest shelf as a way to prevent injuries and spills.

Following are some guidelines and expectations for material storage and use of lab space.

- Avoid bulk chemical storage in the labs by storing large containers, such as four liter bottles, in appropriate storage cabinets underneath fume hoods or in bulk storage cabinets.
- Store only open bottles in the lab and avoid stockpiling material. CA Fire Code requires that no more than 10 gallons of flammable materials be stored in a lab without proper cabinets.
- Small amounts of chemicals can be stored underneath lab sinks. Requirements for these storage areas include the following.
    - A one-gallon bleach container is sufficient for each lab. Bleach is corrosive and rusts the metal of the cabinets.
    - Limit flammable chemicals to one liter or less.
    - Limit chemical storage to bleach, other disinfectants, and small volumes ($\leq$ 1 Liter)
- Avoid storing equipment, supplies, waste containers, and other objects in hallways or in aisles or passageways. Hallways must be freely accessible, and provide safe access and egress during emergencies. Aisles and passageways in the labs are required to have a minimum of 36 inches of clearance. Therefore, equipment and supplies should not be left on the floor or in high traffic areas, and empty boxes should be staged for disposal in a way that minimizes the potential for employees to trip or fall over.
- Avoid storing supplies and waste containers in the knee spaces underneath the benches. Stockpiled equipment and supplies can block exit paths, and eliminates safe refuge for employees during an earthquake.

- Electronic equipment that is no longer being used must be taken out of service and removed from the lab to avoid cluttering the lab. Ask Facilities to find storage space if it is potentially useful in the future or has a chance for resale.
- Store only enough assay kits as needed. If there are unused reagent bottles from kits, then remove and store them until they can be used. If they cannot be used, then contact the Chemical Hygiene Officer about disposing of the material.
- Accumulation of boxes takes up much-needed space. Lab staff are expected to remove unwanted and unused material from their workstations to avoid cluttered and unsafe conditions.

4.10 Maintenance of Safety Equipment

Safety equipment that is built into lab facilities must be maintained in a manner that will facilitate its effective use in the event of an emergency. It is easy to overlook these items until it is time to use it, yet these items are expected to work properly. As part of the general preventive maintenance program at TUC, the following safety equipment is maintained to ensure adequate personnel protection.

- Chemical exhaust hoods are certified annually to meet OSHA requirements for effective air velocity. Chemical exhaust hoods are supposed to operate within a specific velocity range (100 – 150 linear feet per minute), and are required to be checked annually to make sure that the airflow meets this standard.
- Biological safety cabinets are also certified annually to ensure proper airflow. In some cases, these may be certified twice a year.
- Safety showers and eyewash fountains must be tested monthly as a way of ensuring that clean water is available during emergency use and that an adequate flow rate is maintained.
- Fire extinguishers are recharged annually. This involves replacing of extinguishing media while preventive maintenance is performed on the control mechanisms. Fire extinguishers are also supposed to be checked monthly to confirm that they are properly charged and ready for use.
- Annual fire drills are an effective way of checking that all alarms and related systems function properly.

Defective equipment can result in unsafe conditions, so it is incumbent on the users to take equipment out of service until it can be repaired or replaced. In some cases disabled equipment may also damage support systems that can result in untimely and costly repairs. Employees are instructed to report any equipment deficiencies to Facilities and it will be repaired as soon as possible.

4.11 Inspections

Lab inspections are conducted regularly and are described in TUCs Injury and Illness Prevention Plan, and serve as an effective way to identify safety hazards and noncompliance with TUC lab standards. The safety procedures, policies, and guidelines set forth in this and other manuals form the basis for these inspections. Lab inspections are intended to be objective evaluations of safety compliance in labs, and intended to improve and enhance the Safety Program by highlighting the areas where attention to safety and compliance are needed. Inspections are also a way of evaluating the effectiveness of changes to Safety policies and procedures.

Inspections by State and local regulatory agencies are also conducted periodically. The local Fire Department inspects TUC at least annually for Fire Code compliance and Solano County conducts periodic inspections of hazardous waste handling practices. These inspections are intended to help educate the regulated community and can be beneficial in pointing out areas where compliance can be improved.

Reports from each inspection require that efforts be made within a reasonable amount of time to correct or remediate the areas of non-compliance. If there is difficulty complying with an agency request, it is advisable to work with the inspector, or agency, to resolve any outstanding issues. Failure to do so could result in regulatory action against the university or public disclosure of violations.

4.12 Select Carcinogens

OSHA regulates a group of chemicals as “Select Carcinogens”, which are known to cause cancer or show sufficient evidence as suspect carcinogens. TUC has two chemicals on this list, Formaldehyde and Methylene chloride. Under the Select Carcinogens standards the university must identify the methods used to keep the concentrations in the workplace to below the OSHA Action Levels.

4.12.1 Formaldehyde

Formaldehyde is a well-characterized cancer-causing agent and is used to fix cells and tissue in research labs, and is a component of embalming waste generated in the Anatomy Lab.

Formaldehyde is a semi-volatile chemical that is not only a carcinogen but also a combustible chemical. These properties require that Formaldehyde must be handled only in a fume hood until it is diluted to a safe concentration or until sealed and contained or disposed of. The concentration of formaldehyde in embalming fluid is in solution with other hazardous materials and is in concentrations less than 2%. The liquid is collected in a closed system

Due to these concerns, handling of formaldehyde for cell and tissue fixing must take place inside of a fume hood with no exceptions. This ensures that employees are not exposed to the vapors and ensures the workplace concentrations are below the OSHA permissible exposure limit (PEL) of 0.75 parts per million (PPM).

In order to comply with this standard, if it is learned that formaldehyde is used outside of a controlled environment, then exposure monitoring, as defined in

Section 4.8, will be conducted using accepted OSHA protocols and the use of Formaldehyde will be discontinued until assurances can be made that concentrations are below the PEL.

4.12.2 Methylene chloride

Methylene chloride is a suspect carcinogen, and also regulated as a select carcinogen. It is commonly used in chromatography, organics extractions, and has long been a common solvent in organic chemistry.

Methylene Chloride is a combustible material target organ effects on the heart, central nervous system, liver, skin and eyes. Exposure can occur through inhalation, absorption, or skin contact. Methylene Chloride can severely irritate and burn the skin and eyes with possible eye damage, while inhaling Methylene Chloride can irritate the nose, throat and lungs causing coughing, wheezing and/or shortness of breath. Higher exposure can cause headache, nausea, fatigue, dizziness, lightheadedness, weakness and unconsciousness.

The methods by which TUC complies with the Cal/ OSHA requirements for Formaldehyde and Methylene chloride are presented in Appendix B.

5.0 Medical Program

In the event an adverse exposure occurs from any workplace chemical, employees must be provided with appropriate medical attention after an injury or exposure occurs. Exposures may require prolonged medical surveillance and monitoring, depending on the circumstances. Employees must be provided with confidential medical surveillance, guidance, and advice while being treated for chemical exposures.

TUC has an arrangement with Kaiser Permanente Occupational Health Services where employees are sent for medical treatment to non-emergency injuries sustained during business hours. Injuries requiring treatment after hours are to be treated at Kaiser Permanente Emergency Room. Maps and directions for the facility are provided in the Injury and Illness Prevention Plan.

If there is any reason to believe that an employee has been exposed to a hazardous material, the employee must be taken to the health care provider as quickly as possible for evaluation. The health care provider can help answer questions or help establish a medical monitoring program for select chemicals, if necessary. Always provide a Materials Safety Data Sheet (MSDS) to the health care provider after an exposure.

Medical records from exposures and occupational injuries must be retained for the duration of an employee's employment plus 30 years.

First-aid kits are provided for treating minor injuries such as cuts, scrapes, or superficial wounds. First-aid kits are located near the labs and are stocked with band-aids, bandages, medical tape, and other basic first-aid supplies. . These supplies are intended to treat minor cuts or wounds, or to help a person until additional health care is provided.

6.0 Spills and Releases

Cleaning up chemical spills can sometimes pose a greater risk of exposure than working with chemicals in the lab, because of a greater potential for splashes and contamination of clothing and skin exposure. Therefore it is important that employees make personal safety a primary consideration when responding to a chemical spill. **NEVER** try to clean up a spill if untrained or uncertain as to how to proceed.

Do not try to clean up any spill where health and human safety is potentially compromised. It is **very important** that employees know the hazardous properties of spilled materials and to follow one's instincts to avoid exposures from cleaning up spills for which you are ill equipped to handle.

If the chemical cannot be cleaned up, then evacuate others from the work area and contact Security. Security will consult with the University Safety Coordinator to identify the best options. The university's hazardous waste vendor, PSC, can be called to clean up hazardous materials spills. They can be called at

PSC Emergency Spill Response 1-877-577-2669

Even small amounts of toxic material can cause irreversible health risks. For this reason, the following safety considerations must be applied when assessing response to spills.

1. Responding to human health, safety, and welfare is the foremost concern after a spill. If employees have become exposed or contaminated, then help them with decontamination and getting medical treatment.
2. Protect others from exposure and contamination by restricting access to the area. Isolate the spill by placing barriers around the spill, or it may be necessary to stage someone outside the lab until the spill scene is secured.

   If it is possible to approach the spill, then use containment supplies and absorbents to prevent the spill from migrating to other parts of the lab, thus containing it to a small area.
3. Protect sensitive equipment and instruments. Cover or protect sensitive instruments and equipment if you have time.

After the spill is cleaned up and under control, employees involved with the spill are required to report it to the University Safety Coordinator and Chemical Hygiene Officer, as instructed in the Injury and Illness Prevention Plan.

Spills can be prevented by planning experiments, and setting up workstations to maximize bench or hood space, and by thinking in terms of precaution instead of reaction.

Detailed spill response procedures are provided in Section 6.2 in the Emergency Action Plan.

7.0 Hazardous Materials Exposures

Exposures to hazardous chemicals can be severe and should be handled quickly to prevent injuries from such exposures. In all cases, medical follow-up must be provided for all chemical exposures. The following are guidelines in case an employee has been exposed to a hazardous chemical and you are present when a coworker is exposed.

- Call 9-911 for quick response if an employee has been exposed to a particularly harmful chemical, or is exhibiting signs of overexposure. This may include, but is not limited to the following:
  - Difficulty breathing
  - Skin burns that blister or are painful
  - Exposure to the eyes that does not abate after flushing
- Proceed quickly to a safety shower or eyewash fountain if an exposure to the skin or eyes has occurred. Use only plain water and assist co-workers to the safety shower and eyewash fountain if you are not exposed.
- Immediately decontaminate an exposed employee by flushing the exposed part of the body, or eyes, with copious amounts of water for at least 15 minutes.
- Remove contaminated clothing while under the safety shower. A blanket or lab coat can be used to shield the employee for privacy concerns. Make sure all contaminated clothing is removed. Do not worry about water flooding the floor until the employee is decontaminated.
  - After decontaminating an exposed employee under the safety shower, assist the employee to the private showers to flush the body more completely. Showers are located on the second floor of Lander Hall.
- TUC will find clean dry clothing.
- Consider the following actions when aiding a fellow employee with an exposure to the eyes.
  - Help them to the eyewash fountain and push the handle to activate the water flow and begin flushing the eyes.
  - Hold an exposed employee's head under the water stream as long as is necessary.

    - Hold the eyelids open, if necessary, and if the employee is wearing contact lenses they may have to be removed to better irrigate the eyes.
- Call ahead to the health care provider to inform them that an exposed employee is being transported to their facility, and provide a MSDS for the material(s) to which the employee was exposed.
- The effected employee and supervisor will complete an Injury/ Incident Investigation Form and submit it to Human Resources for review. Human Resources will forward this initial report to the Safety consultant who will then conduct a more thorough investigation.

These procedures are also provided in Section 7.0 in the Emergency Action Plan.

8.0 Non-Laboratory Chemical Handling Locations

Safe chemical handling areas outside the lab are covered under the TUC Hazard Communication Plan, which includes Food Service staff, Facilities staff, Custodians, and other service and support staff at the university. These employees handle chemicals for performing specific tasks, yet the principles of safe handling and storage covered in this Plan are still important and will be part of the training for these employees.

9.0 Conclusion

This Plan is updated every year, or as needed, and is required to be read by TUC lab staff. Many of the principles discussed in this Plan are also addressed in different degrees in each of the other safety manuals.

The information in Chemical Hygiene Plan is supplemented with written procedures, training classes, and videos for select operations, group emails, and informational handouts in an attempt to use a multimedia approach to ensure that employees understand the provisions for safe chemical handling.

Appendix A - Classes Of Hazardous Chemicals

The classes of hazardous chemicals handled at TUC include a wide variety of compounds, each with their own unique properties. It is each employee's responsibility to know the hazards of the chemicals they work with and to safely handle them at all times. Many chemicals have more than one hazardous property and employees are instructed to be aware that it is even more important to implement the necessary safety precautions to prevent injuries and accidents. Following are definitions and examples of the major classes of hazardous chemicals. Standard Operating Procedures have been developed to summarize safe handling practices for some of the classes of chemicals discussed below.

<u>Reproductive Health Hazards/ Toxins</u> – These are chemicals that adversely affect the male or female reproductive system, the developing fetus or child. Results include sexual dysfunction, chromosomal damage, mutagenic effects, teratogenic effects, and cancer or chronic disease.

Mutagens – Chemicals that cause inheritable changes in the chromosomes, sometimes exhibiting latent effects, which do not show up until the next generation. A classic example includes ethidium bromide, which is mutagenic to DNA and used in genetic engineering.

Carcinogens – Cancer-causing chemicals can be considered mutagenic because of their ability to mutate DNA causing uncontrolled cell growth. Examples include Benzene, Dichloromethane (methylene chloride), and Formaldehyde. Section 4.12 and Appendix B discuss safe handling practices for the select carcinogens used at TUC.

Teratogens – Chemicals that cause birth defects in offspring. Teratogenesis is the result of a chemical causing congenital deformity and includes mercury and organic mercury compounds, and ethanol.

<u>Flammable or Combustible Chemicals</u> - Chemicals that are capable of igniting when vapors mix with air and a source of ignition is present. These are volatile at room temperature with the degree of risk is based on the flash point of the chemical.

Flammable – any liquid having a flash point below 100 deg. F. (37.8 deg. C.), except any mixture having components with flash points of 100 deg. F. (37.8 deg. C.) or higher. Flammable liquids are classified as Class I, II, or III based on the specific properties.

Class IA - liquids having flash points below 73oF (22.8oC) and having a boiling point below 100oF (37.8oC).

Class IB - liquids having flash points below 73oF (22.8oC) and with a boiling point at or above 100oF (37.8oC).

Class IC - liquids having flash points at or above 73oF (22.8oC) and below 100oF (37.8oC).

Combustible - any liquid having a flash point at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C).

Class II liquids - flash points at or above 100oF (37.8oC) and below 140oF (60oC), except any mixture having components with flash points of 200oF (93.3oC) or higher, the volume of which make up 99 percent or more of the total volume of the mixture.

Class III liquids - flash points at or above 140oF (60oC). Class III liquids are subdivided into two subclasses:

> **Class IIIA** liquids shall include those with flash points at or above 140oF (60oC) and below 200oF (93.3oC), except any mixture having components with flash points of 200oF (93.3oC), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.
>
> **Class IIIB** - flash points at or above 200oF (93.3oC).

Safe Work Practices

- Do not use flammable chemicals near an open flame.
- Avoid static electricity or hot surfaces because of the potential as ignition sources.
- Storage containers greater than five gallons must be electrically grounded.
- Transfer flammable liquids from larger containers (4 Liters0 must be performed in a laboratory hood.
- At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when working with hazardous chemicals.
- When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn.
- Goggles (vs. safety glasses) are appropriate in processes where splashes or sprays are possible.
- Volumes of flammables exceeding 1 gallon must be stored within a flammable storage cabinet.
- Fire extinguishers appropriate for the fire hazards present must be available in all laboratories and storage areas. Class D fire extinguishers must be available in the immediate work area when working with flammable metals such as magnesium, sodium, and potassium.
- Flammable materials, including waste, must be stored in secondary containment when not stored in an approved cabinet.
- Segregate flammables from oxidizers and acids.

<u>Corrosives</u> – Chemicals capable of corroding metals, and causing severe burns upon exposure. The two types of corrosives are dependent on the pH scale of 0 - 14.

Corrosive materials cause destruction of tissue through chemical action at the point of contact. Corrosive chemicals can be liquids, solids, or gases, of which exposures most commonly affect the skin, eyes, and respiratory tract.

Acids – Solutions with a pH below 5.5. Examples include acetic acid, hydrochloric acid, and trichloroacetic acid.

Bases – Chemicals with a pH above 8. Examples include sodium hydroxide, ammonium hydroxide, and

Safe Work Practices

- Use a properly functioning lab fume hood when handling strong acids/ bases, or other chemicals that can form vapors upon contact with air (often referred to as "fuming").
- If the process does not permit the handing of such materials in a fume hood, contact the TUC Facilities Department to review the adequacy of ventilation measures.
- Handling processes should be designed to minimize the potential for splash, splatter, or other likely scenarios for accidental contact.
- Do not pour water into acid. Slowly add the acid to the water and stir.
- Never empty carboys or drums of chemicals by means of air pressure. Use a tilting rack, a safety siphon, or a liquid pump.
- Open bottles or carboys slowly and carefully and wear protective equipment to guard hands, face, and body from splashes, vapors, gases and fumes. Wipe drips and visible residues of sodium hydroxide and potassium hydroxide from all surfaces. Skin contact with dry residue will result in burns.
- Ensure secondary containment and segregation of incompatible chemicals per guidance within the <u>TUC</u> Chemical Storage Manual. Also, follow any substance-specific storage guidance provided in MSDS documentation.
- **Never** store corrosive chemicals above eye level.

<u>Reactive Chemicals</u> – Chemicals that under ambient conditions create a violent reaction, frequently with explosive results. Highly reactive or unstable materials are those that have the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, temperature, light, or contact with another material. Examples include explosives, peroxides, water-reactives, and pyrophorics such as metal hydrides or rare metalloids.

Safe Work Practices

- Accommodate for adequate temperature control and heat dissipation when handling reactive or incompatible materials.
- Always provide pressure relief mechanisms for reactions where pressure build-up can occur.
- Glass equipment operated under vacuum or pressure must be shielded, wrapped with tape, or otherwise protected from shattering.
- A designated area shall be established for highly unstable materials that are also considered particularly hazardous substances.
- Minimize the quantity of reactive chemicals used or synthesized to the smallest amount needed.
- Use chemical-specific precautions for mixing even small quantities. These may include
- **Never** leave a reaction using these materials unattended or running overnight.
- Chemical reactions conducted at temperatures or pressures above or below ambient conditions must be performed in a manner that minimizes risk of explosion or vigorous reaction.
- Use shields and barricades, and personal protective equipment (such as face shields with throat protectors and heavy gloves) whenever there is a possibility of explosion or vigorous chemical reaction.
- Wrap-around goggles (not safety glasses) are most appropriate for processes where splash or spray is foreseeable.
- Wear additional protective clothing (i.e., face shield, apron, over sleeves) for reactive chemicals that are toxic via skin contact/ absorption.

Allergens – A substance that causes an allergic or autoimmune reaction. Examples include allergic reactions to latex gloves, formaldehyde, and toluene. Employees who handle animals may also be subject to developing allergic response to certain species.

Toxic Chemicals – Classified based on the capability to cause an adverse systemic effect after exposure. All chemicals exhibit some degree of toxicity, and in this context toxicity is further defined by the following.

Acutely Toxic – Can cause adverse health response shortly after exposure, often lasting only a short time. Though not true of all chemicals, the health effects are often reversible from acute exposure. Examples include nicotine, arsenic, and cyanogens bromide.

Chronically Toxic – Chemicals that can cause a persistent, or long-lasting, health effect after exposure. Some compounds do not manifest symptoms until years later, after repeated exposures to small quantities of chemicals throughout the course of a career. Common examples include most organic solvents handled in the lab, such as alcohols, methylene choride, and formaldehyde.

Compressed Gases – Compressed gas cylinders are defined as posing a risk to health and safety from the high pressure and from the physical and health risks associated with the chemical. Hazards associated with compressed gases include oxygen displacement, fires, explosions, and toxic gas exposures, as well as the physical hazards associated with high-pressure systems. Special storage, use, and handling precautions are necessary in order to control these hazards.

Safe Work Practices

- Ensure that cylinders are clearly identified. Vendor labels must not be defaced or removed.
- Leave valve protection caps in place when not in use.
- Keep cylinder valves closed except when the cylinder is being used. Closing the valve isolates the cylinder's contents from the surrounding atmosphere and prevents corrosion and contamination of the valve.
- When opening a cylinder valve, stand to the side of the regulator and open it slowly
- Never tamper with or alter cylinders, valves, or safety-relief devices.
- Do not drag or roll cylinders and move with a suitable hand truck, lift truck with a cradle to move cylinders of compressed gas.
- All cylinders must be double chained in the support rack. Chains should be placed at 1/3 and 2/3 the height of the cylinder from the floor.

Appendix B - Methods for Controlling Select Carcinogens

Among the many carcinogenic agents identified by occupational and public health agencies and organizations, OSHA has established a select carcinogens list, which is regulated separately from other hazardous materials. OSHA requires the following provisions in work settings where these agents are handled. As stated in Section

TUC handles Paraformaldehyde in high concentrations and dilutes this to a 10% solution to “fix” cells or tissue. This is the same concentration as Formalin, which is also regulated as part of this OSHA standard.

The Anatomy lab also has low concentrations of formaldehyde in the embalming fluid waste draining from cadavers. This is mixed with other organic constituents and is collected in closed-topped bottles, which do not permit these vapors to escape.

Methylene chloride s used in organic chemistry and is limited to use in a fume hood in Lab 103.

Safety provisions for select carcinogens include the following:

1. Establish a specific designated area for handling select carcinogens.

   Both select carcinogens must be used exclusively in the chemical exhaust hood.

   Formaldehyde is opened and decanted into a small lab tray, where it is then introduced to the cells in either a 12 well plate or a 96-well plate. Excess formaldehyde is disposed of in the liquid flammable waste container. After allowing the formaldehyde to sit on the cells for about 5 minutes, the excess is disposed of accordingly.

   Methylene chloride is decanted in to a transfer vessel and then used in reactions and extractions in the hood.

2. Fume hoods, glove boxes, or equivalently acceptable containment devices must be used whenever possible.

   Formaldehyde and methylene chloride must be used exclusively inside of a chemical exhaust hood. The Principal Investigator (PI) has the option of restricting access to this lab during the handling of this chemical.

3. Procedures for the safe disposal of waste.

   A flammable waste container that is profiled to accept waste, including small volumes of formaldehyde, is kept in, or under, a in the lab. This is intended to provide safe disposal while keeping the material in a controlled environment.

4. Decontamination procedures.

   After all clean up materials have been properly disposed from spills or contamination the affected surfaces are decontaminated with a soap and water solution followed by a final cleaning with a 70% solution of isopropanol.

5. PPE removal from a designated area.

Lab employees are trained to remove PPE including lab coats and gloves before leaving the laboratory. Coat racks are installed outside each lab to accommodate this practice.

6. Mechanical pipetting aids are used for all pipetting procedures; mouth pipetting is prohibited.

7. Laboratory work surfaces on which a carcinogen is handled shall be protected from contamination.

   The work surface in the fume hood is impervious to harsh chemicals, is easily cleaned, and is recessed below the face of the hood to provide spill containment for small spills. The surface is cleaned after each use of formaldehyde.

8. Employees are required to wear protective laboratory clothing whenever they are working in the lab. At a minimum, employees are required to wear lab coats, safety glasses, and nitrile gloves when handling these materials.

9. There shall be no connection between regulated areas and any other areas through the ventilation system.

   The exhaust hoods operate with an independent air-handling unit from the rest of the facility, and there are no suspected releases of vapors while the hoods are in operation.

10. Air monitoring will be conducted and medical surveillance will be provided if there is reason to believe that concentrations of select carcinogens exceed permissible exposure limits.

    A qualitative assessment of potential workplace concentrations concludes that employees are not exposed to harmful vapors when working in the fume hood.

Formaldehyde

Quantity of formaldehyde used:	Less than 100 ml
Duration of Use:	1 hour
Average ventilation rate of hood:	161 lfpm
PEL/ STEL:	0.75/ 2.0 ppm

Methylene chloride

Quantity of formaldehyde used:	Less than 500 ml
Duration of Use:	Less than 30 minutes
Average ventilation rate of hood:	161 lfpm
PEL/ STEL:	25 ppm/ 87 ppm

Assuming that the air velocity meter on the fume hood functions properly, the concentration of Formaldehyde inside the fume hood is no more than 0.1 W/W by volume/ 1.0 m^3 or air. Given the volumes of formaldehyde rarely exceeds 2 ml, and most of it is disposed of as waste, the formaldehyde remains in its aqueous phase until disposed. Based on these parameters, it is assume that employee exposures are well below the OSHA permissible exposure level.

Quantitative exposure monitoring will be conducted in accordance with the Cal/ OSHA standard, and anytime thereafter when conditions change or the assay or experiment changes.

11. Employee information and training

    Employees are informed by way of lab safety training and during new employee safety orientation of the risks and safe work procedures for handling this and other reproductive hazards.

12. Recordkeeping requirements

    TUC registers the use of Formaldehyde and Methylene chloride with Cal/ OSHA, as required, and all the appropriate use records, exposure monitoring data, and all other details from its use will be maintained in the office of the Chemical Hygiene Officer, or equivalent.

Appendix C – Proper Use of A Chemical Exhaust Hood

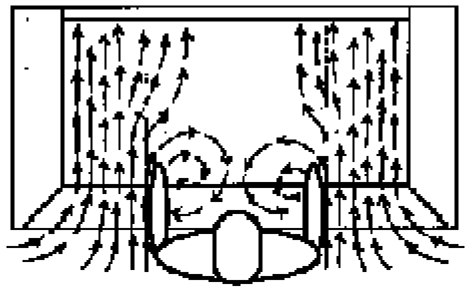
One of the most important safety devices in a laboratory is a properly functioning fume hood. The fume hood protects users from inhaling chemicals by constantly pulling air into the hood and exhausting it out of the building. Fume hoods also provide protection in the event of an explosion or fire. A fume hood should be used in the following situations:

- When handling chemicals with significant inhalation hazards such as toxic gases, toxic chemical vapors and respirable toxic powders.
- When carrying out experimental procedures with strong exothermic reactions.
- When handling chemicals with significant vapor pressure.
- When chemical vapors generated could cause a fire hazard.
- When working with compounds that have an offensive odor.

Conventional Hoods -- Conventional hoods represent the original and most simple of the hood design styles. With a conventional hood the volume of air exhausted is constant, regardless of sash height. As the sash is lowered the opening area decreases, resulting in an increase in face velocity. Since face velocity changes dramatically with sash position it is particularly important when working with conventional hoods to maintain the sash at its optimal height as indicated by the arrow label attached to the hood frame. Optimal sash height represents the point where face velocity equals at least 100 fpm.

Safe Sash Heights

To capture vapors adequately, a fume hood must provide an average face velocity of >100 linear feet per minute. However, excessive air velocities can cause turbulence that may bring the contaminants back into the user's breathing zone. (See drawing.)



The following guidelines are intended to help employees understand the importance and value that chemical fume hoods provide.

- Adjust the sash. Position sashes at the arrows to ensure proper airflow velocities at the work opening. Adjust the sash to shield yourself from splashes or flying objects. Horizontally sliding sashes can be used as a body shield by wrapping your arms around the sash panel as you work.
- By law, all hoods must have an indicator that indicates air velocity. New hoods often have alarms when air velocity drops below recommended levels.
- Minimize storage. Do not take up hood space and block ventilation by storing unused equipment or chemicals in hoods. If large items must be kept in the hood, contact the Chemical Hygiene Officer for evaluation and a test.
- Keep all work at least 6 inches inside the hood. The capture ability of a fume hood may not be 100% at the front of the hood.
- Never lean your head inside the fume hood when chemicals are present.
- Never close non-bypassed hoods completely. Leave at least a two-inch sash opening, particularly if flammable materials are present in the hood.
- Avoid cross drafts. Someone walking rapidly past the work opening can create a cross draft that may disturb the direction of airflow and cause turbulence.
- Prevent pollution. The chemical vapors generated in most hoods are exhausted into the atmosphere. To minimize pollution, seal all chemical containers not in use. Never use the hood to vent excess chemical waste. Local regulations require that all chemical containers must be capped when not being used.
- Keep the hood clean. Remove old experimental glassware and clutter. Wipe up spilled chemicals or residues. Make sure you can see through the glass sash.

Do not adjust the damper. Doing so may adversely affect fume hoods in other room.

Appendix D - Emergency Spill Procedures

CHEMICAL SPILLS

NEVER clean up an unknown chemical or try to handle a spill you are not trained to clean up!

Call 9-911 if an employee is:

- **Unconsciousness**
- **Exposed to hazardous materials**
- **Suffering uncontrolled bleeding**
- **Traumatically injured**

Human Health and Safety Comes First During a Spill!

1. **Check yourself for contamination or exposure to hazardous chemicals**
2. **If exposed, quickly proceed to a safety shower or eyewash fountain and flush yourself for at least 15 minutes.**
3. **If all employees are safe, alert others to the spill and restrict access.**
    - **Place warning signs or caution tape around the spill area.**
    - **Prevent people from entering the spill area.**
4. **Put on appropriate Personal Protective Equipment. At a minimum:**
    - **Lab Coat**
    - **Safety Goggles (wrap around rubber style)**
    - **Large chemical-resistant gloves (Latex, neoprene, or Nitrile)**
5. **Surround the perimeter of the spilled chemical with absorbent materials.**
6. **Remove broken glass or contaminated sharps with tongs.**
7. **Apply absorbent materials on top of the spill.**
8. **Starting from the outer edges clean toward the middle of the spill.**
9. **Collect all spill materials in a plastic waste bag, placing a completed hazardous waste label on the bag.**
10. **Decontaminate the spill area with a soap and water solution.**