OFFICE OF RESEARCH SAFETY
RS001 - Chemical Hygiene Plan

No./Title: CHEMICAL HYGIENE PLAN	**Resp. Office:** Research Safety	**Effective Date:** 10/01/17
Category: Office of Research Safety	**Last Review:** NEW	**Next Review:** 10/01/2018
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Related Policies: RS102 Incident Reporting		

PURPOSE, SCOPE, AND APPLICABILITY

The University of Tennessee Health Science Center (UTHSC) is committed to providing a healthy and safe work environment for the campus community. This Chemical Hygiene Plan (CHP) establishes a formal written program for protecting laboratory personnel against health and safety hazards associated with exposure to hazardous chemicals and must be made available to all employees working with hazardous chemicals in a laboratory setting. The CHP describes the proper use and handling procedures to be followed by faculty, staff, and all other personnel working with hazardous chemicals in laboratory settings.

This procedure will meet the requirements of a chemical hygiene plan, as defined by the U.S. Occupational Safety and Health Act (OSHA) of 1970 and regulations of the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

The CHP applies to all laboratories that use, store, or handle hazardous chemicals and all personnel who work in these facilities.

ABBREVIATIONS, ACRONYMS, AND DEFINITIONS

Chemical Hygiene Officer (CHO) - Individual with the responsibility as defined in the OSHA Laboratory Standard to implement the Chemical Hygiene Plan thus ensuring compliance with the regulatory requirements and maintaining a safe work environment.

Hazardous substance – Any substance that is capable of causing an acute or chronic health condition in humans or adversely impacting the environment. Substances that are considered physical hazards (flammable substances, explosives, shock sensitive, etc.) are included in the definition of a hazardous substance. The OSHA Hazard Communication Standard, 29 CFR 1910.1200 and the OSHA Chemical Hygiene Plan 29 CFR 1910.1450 are the two main standards that define a hazardous substance

Permissible Exposure Limit (PEL)-An exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either a time-weighted average (TWA) exposure limit (8 hour), a 15-minute short term exposure limit (STEL), or a ceiling (C).

Laboratory Safety Officer – Individual delegated by the Laboratory Supervisor to have responsibility for lab safety and compliance and the authority to implement corrective actions within the lab. Since PIs or Lab Supervisors are not often in the lab and may have limited time to tend to administrative and regulatory responsibilities the presence of a Lab Safety Officer is useful in promoting compliance in research work areas.

Laboratory Supervisor – Individual responsible for day-to-day supervision or oversight of the laboratory operation and personnel working in the laboratory. This is often the Principal investigator of a grant funded laboratory.

Principal Investigator (PI) - The holder of an independent grant administered by a university and the lead researcher for the grant project, usually in the sciences, such as a laboratory study or a clinical trial. The phrase is also often used as a synonym for "head of the laboratory" or "research group leader."

Safety Data Sheet (SDS) - Written or printed material concerning a hazardous chemical that is prepared in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200). Formerly known as Materials Safety Data Sheets (MSDS), an SDS contains information on the potential health effects of exposure to chemicals, or other potentially dangerous substances, and on safe working procedures when handling chemical products.

Standard Operating Procedures (SOPs) – A set of step-by-step instructions compiled by an organization to help workers carry out complex routine operations. SOPs aim to achieve efficiency, quality output and uniformity of performance and provide for the safety of researchers while reducing miscommunication and failure to comply with regulations.

Designated Area - An area which may be used for work with "select" carcinogens, reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

RESPONSIBILITIES

- Principal investigator or Laboratory Supervisor Responsibilities
  The Laboratory Supervisor is the individual ultimately responsible for the overall laboratory operation, including the lab safety program, and ensuring that the requirements of the CHP are followed by all staff members that work in the lab. For most research laboratories, the Principal Investigator (PI) is the Laboratory Supervisor. In cases where the PI has hired an individual such as a lab manager or senior researcher to manage the daily operations of the lab the PI is still ultimately responsible for the overall operation of the lab and is considered to be the Laboratory Supervisor. Since the Laboratory Supervisor does not necessarily have a routine presence within the lab it is appropriate to delegate some safety duties to a qualified individual. Examples of such delegated responsibilities includes ensuring compliance with SOPs, PPE, updating of chemical inventories, etc. Ultimately, however, the

Laboratory Supervisor remains responsible for the safety of all personnel working in the laboratory.

Specifically, the Laboratory Supervisor must:

- Understand applicable environmental health and safety rules, including the contents of the CHP;
- Assess hazards in the laboratory, document this assessment, and instruct lab personnel to properly mitigate the risk associated with these hazards. This may be through the use of engineering controls (e.g. Fumehood), administrative controls (e.g. work practices) or PPE.
- Establish SOPs to effectively control or reduce hazards;
- Ensure that all laboratory personnel that work with hazardous chemicals receive appropriate training;
- Maintain written records of lab-specific training (e.g., PPE training, review of IBC protocols, etc.);
- Ensure that appropriate PPE (e.g., laboratory coats, gloves, eye protection, etc.,) and engineering control equipment (e.g., chemical fume hood) are made available, in good working order, and being used properly;
- Conduct periodic lab inspections and immediately take steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards; and
- Maintain an accurate inventory of hazardous chemicals stored or handled within their work areas.
- Actively enforce all applicable safety procedures and ensure that the CHP is followed by lab staff and all visitors, including having a progressive disciplinary process for lab staff members that do not comply with safety rules.

- Laboratory Employee Responsibilities
  All employees (e.g., researchers, graduate research assistants, graduate students, undergraduate students, lab technicians, post-doctoral researchers, and visiting scientists) in laboratories that use, handle, or store hazardous chemicals must:

  - Review and follow the requirements of the CHP;
  - Follow all verbal and written laboratory safety rules, regulations, and SOPs required for the tasks assigned;
  - Develop and practice good personal chemical hygiene habits such keeping work areas clean and uncluttered;
  - Plan, review, and understand the hazards of materials and processes in the laboratory prior to conducting work;
  - Utilize appropriate measures to control hazards, including consistent and proper use of engineering controls, administrative controls, and PPE;
  - Understand the capabilities and limitations of PPE;

- Immediately report all accidents, near misses, and unsafe conditions to the Laboratory Supervisor;
- Complete all required safety training and provide written documentation to the Laboratory Supervisor;
- Participate in the medical surveillance program when required; and
- Inform the Laboratory Supervisor of any work modifications ordered by a physician as a result of medical surveillance, occupational injury, or chemical exposure.

- Laboratory Safety Officer Responsibilities
  It is highly recommended that each Laboratory Supervisor establish a Laboratory Safety Officer to manage the daily operations of the lab's safety program. The Laboratory Safety Officer may also operate as the Chemical Hygiene Officer for the laboratory. The Laboratory Supervisor should empower the Laboratory Safety Officer to enforce requirements of this CHP among other lab personnel. The Laboratory Safety Officer should be familiar with how the lab operates and have demonstrated lab safety experience (e.g., senior graduate student, post-doc, lab manager).

  The role of the Laboratory Safety Officer could include the following responsibilities:

  - Provide training to new lab personnel and ensure that the training is properly documented;
  - Enforce lab safety rules;
  - Update hazardous chemical inventory
  - Report safety issues back to the Laboratory Supervisor when necessary;
  - Contact the Office of Research Safety and follow up with them as necessary to resolve safety issues within the laboratory.

- Non-Laboratory Personnel/Support Staff Responsibilities:
  Housekeeping and Facilities maintenance staff (support staff) may enter laboratories to perform routine tasks such as cleaning and equipment maintenance. Support staff members are expected to follow the posted safety rules of each laboratory. Minimum PPE requirements for support staff working in a laboratory are long pants, closed-toe shoes, safety glasses and gloves. If additional PPE is required or if other unique safety requirements must be followed, it is the responsibility of laboratory personnel to notify support staff. These additional requirements should be clearly communicated to support staff. Posting the requirements on the lab door or somewhere else highly visible is recommended.

- Chemical Hygiene Officer Responsibilities:
  The Chemical Hygiene Officer has the primary responsibility for ensuring the implementation of all components of the CHP. The Director of the Office of Research Safety operates as the Chemical Hygiene Officer for the institution. Individual departments or laboratories are

encouraged to designate a Chemical Hygiene Officer for their department or lab. The Chemical Hygiene Officer must:

- Inform Laboratory Supervisors of all health and safety requirements and assist with the selection of appropriate safety controls (engineering controls, administrative controls, and PPE);
- Ensure that Laboratory Supervisors have the necessary resources to maintain compliance with the CHP and that all lab staff receive appropriate training;
- Conduct periodic lab inspections and immediately take steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
- Ensure that SOPs and hazard assessments are being prepared;
- Maintain employee exposure-monitoring records, when applicable;
- Help to develop and implement appropriate environmental health and safety policies and procedures;
- Review and evaluate the effectiveness of the CHP program at least annually and update it as appropriate; and
- Actively enforce all applicable safety procedures and ensure the contents of the CHP are followed; take appropriate actions when safety procedures are not followed.

UNIVERSAL LABORATORY SAFETY PRACTICES

Certain laboratory safety practices apply to all laboratories or research areas where hazardous chemicals may be handled. These practices must be followed by all personnel working within such areas and shall be enforced by the Laboratory Supervisor:

- Employees shall not eat, drink, smoke, or apply cosmetics within a laboratory.
- Employees shall not wear open toed shoes or perforated shoes.
- Employees shall not wear shorts, skirts or dresses that do not provide skin coverage to at least below the knee. Pants are strongly preferred.
- Whenever feasible, employees should handle hazardous chemicals within a laboratory chemical hood.
- Employees shall not block access to exit doors, fire extinguishers, fire alarm pull stations, eyewash stations, emergency showers or other emergency equipment.
- Employees shall not leave laboratory experiments unattended.
- Employees shall wash hands after handling hazardous chemicals.
- Employees shall keep long hair (longer than shoulder length) tied back.
- Employees shall keep container sizes and quantities on hand as small as possible; such quantities shall be consistent with the rate of use. Employees should only purchase quantities necessary for experiments and procedures occurring in the immediate future.
- Employees shall keep work areas, where hazardous chemicals are handled, clean and uncluttered.

HAZARD COMMUNICATION

Hazard recognition is a fundamental component of chemical safety. UTHSC complies with the TOSHA Hazard Communication Standard to ensure that employees are properly informed about the hazards associated with the chemicals in their work area. Due to the variety of chemicals located across the campus it is the responsibility of supervisors to ensure that staff members are aware of the hazards associated with the chemicals in their work area. This shall be done through labelling, the maintenance of a hazardous chemical inventory, Safety Data Sheets, and training.

- Labelling

  Every chemical container present in the laboratory, whether hazardous or not, must be properly labeled. Each hazardous chemical container shall be labeled, tagged or marked with the following information:

  - Identity of the hazardous chemical(s)
  - Appropriate hazard warnings, including words, pictures, and/or symbols, which provide general information regarding the hazards of the chemicals. (The NFPA diamond hazard rating system is an acceptable means of describing the appropriate hazard warnings.)

  Existing labels on incoming containers of hazardous chemicals shall not be removed or defaced, unless the container is immediately marked with the required information. Portable containers of hazardous chemicals do not require labeling if they are transferred from labeled containers and are intended for immediate use by the employee who performs the transfer. Food, beverages, and drugs in solid final form ready for administration to a patient are exempted from the labeling requirements.

  Avoid using abbreviations, chemical formulae, or structure unless there is a complete and up-to-date legend (e.g., MeOH = Methanol) prominently posted in the lab. Most chemicals come with a manufacturer label that contains all of the necessary information, so care should be taken to not damage or remove these labels. It is recommended that each bottle also be dated when received and when opened to assist in determining which chemicals are expired and require proper disposal.

- Chemical Inventories

  Departments that handle, use or store hazardous chemicals are required to maintain an inventory of such chemicals. Laboratory Supervisors must review and update the chemical inventory as often as necessary to ensure its accuracy, but at least annually. This inventory will be maintained either by spreadsheet or online software (such as EHS Assistant software application accessible through the Office of Research Safety website). The Office of Research Safety will help maintain this online inventory. This inventory must accurately represent the hazardous chemical inventory of the lab.

  Generally, all hazardous chemicals, compressed gases, hazardous drugs, chemotherapy agents, contrast media, and other pharmaceuticals should be listed on the hazardous

chemical inventory. TOSHA defines a hazardous chemical as a substance (liquid, solid, gas, vapor, aerosol, fume, dust or mist) which is a physical hazard or a health hazard. A health hazard is a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. A health hazard may include chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. A physical hazard is a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

Select items are exempt from being included on a hazardous chemical inventory:

- Food and beverages are exempt.
- The following pharmaceuticals are exempt:
- Drugs when they are in their solid final form for direct administration to a patient (e.g., tablets, pills, and creams),
- Over-the-counter drugs (not requiring a prescription), and
- First aid kits (for employee use).
- Hazardous waste and radioactive materials are exempt.
- Biohazardous materials, culture media and blood culture bottles are exempt.
- Alcohol gel dispensers mounted on the wall or sitting on desks are exempt. However, if multiple containers of alcohol gel are kept in a central storage location, such containers should be listed on the inventory.
- “Articles” and “consumer products” are exempt. An “article” is any manufactured item other than a fluid or particle which, 1) is formed to a specific shape or design during manufacture, 2) has end use function(s) dependent in whole or in part upon its shape or design during end use, and 3) which under normal conditions of use does not release more than very small quantities, e.g., minute or trace amounts of a hazardous chemical and does not pose a physical hazard or health risk to employees. A “consumer product” is any article, or component part thereof, produced or distributed 1) for sale to a consumer for use in or around a permanent or temporary household or residence, a school, in recreation, or otherwise, or 2) for the personal use, consumption or enjoyment of a consumer in or around a permanent or temporary household or residence, a school, in recreation, or otherwise. Examples of exempt “articles” and “consumer products” include liquid paper, alkaline batteries, Sani-wipes, cleaning products (at an employee’s desk), and printer cartridges. Consumer products that are used in a manner that is consistent with how one would use such products at home are exempt. For example, Windex Cleaner kept at an employee’s desk for periodic cleaning of his/her desk is exempt. However, if a housekeeper uses Windex Cleaner multiple times per day for execution of his/her work duties, such cleaners should be included on the inventory.

- Safety Data Sheets (SDS)
  The SDS provides comprehensive information for the safe handling and storage of hazardous chemicals. They enable the employer to develop an active program of hazard communication and worker protection measures. Laboratory personnel should use the SDS as a resource to obtain information about hazards and safety precautions. UTHSC makes SDSs accessible through the internet for the wide variety of chemical reagents and products on campus. They are routinely accessible on manufacturer websites or can be obtained by using a search engine to browse the internet. Work areas where employees do not have access to internet-connected computers must maintain hard copies of SDS for the hazardous chemicals handled in that area.

- Training
  General hazard communication training is provided by the Office of Research Safety and is a component of the annual training requirement for all researchers. This content includes labelling requirements, SDS access, and the recognition of warning signs such as GHS pictograms as required by OSHA. This does not complete the hazard communication requirement for employees. Work area supervisors are required to provide additional training on the hazards associated with the specific chemicals present in each employee's work area. This training must include, at a minimum, the health hazards associated with each chemical, the signs and symptoms of exposure and appropriate actions to take in the event of an exposure.

LABORATORY HAZARD ASSESSMENT

Supervisors are responsible for assessing the hazards associated with the use of chemicals and other hazardous agents in laboratories. In accordance with OSHA Standard 29 CFR 1910.132 this assessment must be documented through a written certification that identifies the workplace evaluated; the person certifying that the evaluation has been performed; the date(s) of the hazard assessment; and, which identifies the document as a certification of hazard assessment. The Laboratory Hazard Assessment (shown in Figure 1) must be posted on the door to the laboratory work area and is available in Appendix A.

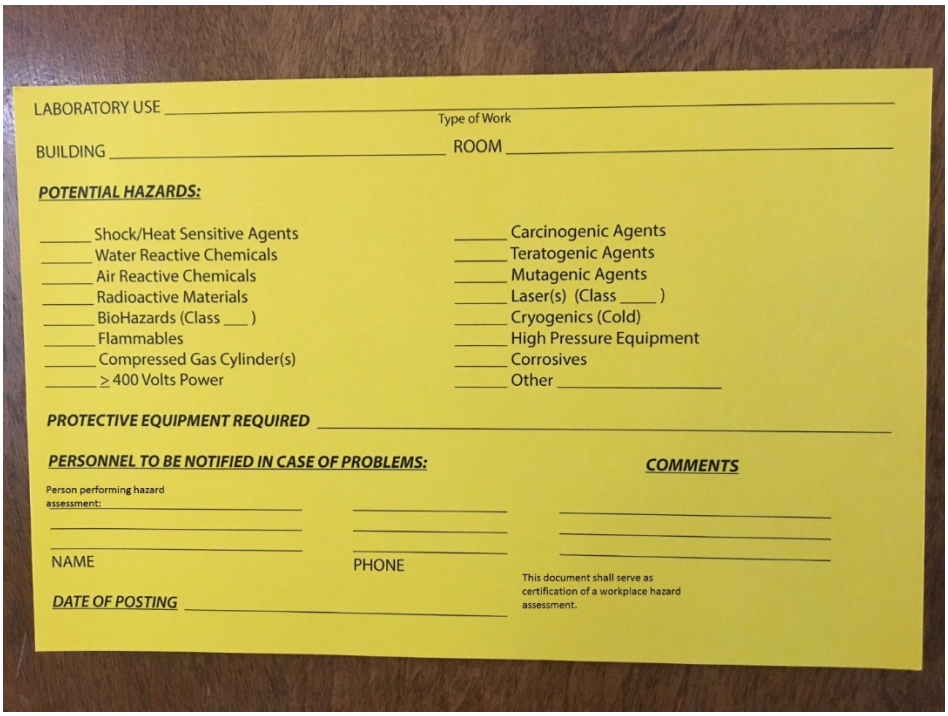
If hazards are present, or likely to be present, the laboratory supervisor shall ensure employees utilize proper controls to limit exposures to such hazardous chemicals. Hazards are controlled with engineered systems (e.g., fume hoods, containment devices, ventilation, etc.), work practices, and/or personal protective equipment (PPE).

When assessing hazards, supervisors should consider the following steps:

1. List the job tasks
2. Identify the hazards associated with each job task
3. Identify control(s) for each hazard
4. Implement control(s)
5. Educate affected employees

6. Evaluate effectiveness of the control(s).

Laboratory Supervisors are encouraged to consult with the Office of Research Safety when assessing procedures that may be deemed as highly hazardous. When completed by the Laboratory Supervisor or a representative from the Office of Research Safety the following form meets the criteria for a workplace hazard assessment. It may be obtained from the Office of Research Safety.



LABORATORY USE _____
Type of Work

BUILDING _____ ROOM _____

POTENTIAL HAZARDS:

_____ Shock/Heat Sensitive Agents
_____ Water Reactive Chemicals
_____ Air Reactive Chemicals
_____ Radioactive Materials
_____ BioHazards (Class ___)
_____ Flammables
_____ Compressed Gas Cylinder(s)
_____ ≥ 400 Volts Power
_____ Carcinogenic Agents
_____ Teratogenic Agents
_____ Mutagenic Agents
_____ Laser(s) (Class ____)
_____ Cryogenics (Cold)
_____ High Pressure Equipment
_____ Corrosives
_____ Other _____

PROTECTIVE EQUIPMENT REQUIRED _____

PERSONNEL TO BE NOTIFIED IN CASE OF PROBLEMS:

COMMENTS

Person performing hazard assessment: _____ _____ _____

_____ _____ _____

_____ _____ _____

NAME PHONE

This document shall serve as certification of a workplace hazard assessment.

DATE OF POSTING _____

Figure 1: Laboratory Workplace Hazard Assessment

HIERARCHY OF CONTROLS

Laboratory safety controls are used to minimize the potential for exposure to hazardous chemicals. These controls include engineering controls (e.g. fumehoods), administrative controls (e.g. work practices), and PPE. Elements of these three categories should be used in a layered approach to minimize employee exposure to hazardous chemicals. The hierarchy of controls prioritizes hazard mitigation strategies on the premise that the best way to control a hazard is to systematically eliminate it from the workplace or substitute a less hazardous technique, process, or material. If elimination or substitution are not feasible options, administrative controls, engineering controls, and PPE must be used to provide the necessary protection.

It is the responsibility of laboratory employees to practice good chemical hygiene at all times. To do this the employee must be familiar with the four routes of exposure in which hazardous substances can enter the body: inhalation, absorption, ingestion, and injection. Of these, the most likely routes of exposure in the laboratory are by inhalation or skin absorption. Many

hazardous chemicals may affect people through more than one of these exposure routes, so it is critical that protective measures are in place for each of these exposure routes. For each laboratory procedure employees should evaluate the potential routes of exposure and apply the hierarchy of controls to mitigate the risk associated with that procedure.

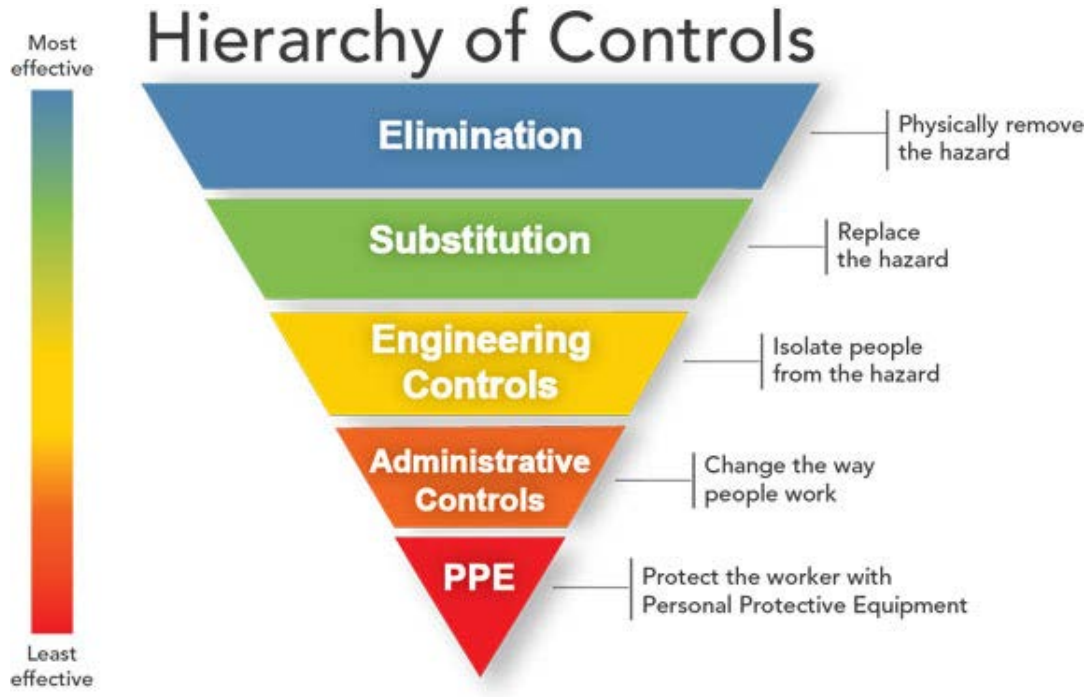


Figure 2: Hierarchy of Controls

ENGINEERING CONTROLS

Engineering controls eliminate or reduce exposure to a chemical or physical hazards through the use or substitution of engineered machinery or equipment. Common forms of engineering controls often employed in the laboratory include equipment to isolate the operator or the process (e.g., use of a glove box when handling air- or water-sensitive chemicals); and use of forced ventilation systems (e.g., chemical fume hood, biological safety cabinet).

- Chemical Fume Hoods
  Laboratory chemical hoods are designed to partially enclose processes and or equipment that generate air contaminants such as gases, vapors, fumes or particulates. Whenever possible, employees should handle hazardous chemicals within laboratory chemical hoods. The location of a laboratory chemical hood affects its effectiveness in capturing and/or containing air contaminants. Ideally, laboratory chemical hoods should be located in an area of minimal traffic. When a person walks by a laboratory chemical hood, turbulence can be created near the hood face causing contaminants to be drawn outside the hood.

Laboratory chemical hoods shall be evaluated annually by the Office of Research Safety. The evaluation shall include a face velocity test, airflow visualization test, and airflow alarm assessment test. The evaluation procedure is contained within Appendix B: Laboratory Chemical Hood Evaluation Procedure. Each laboratory chemical hood shall be labeled with a sticker indicating the last successful evaluation date for such hood. Laboratory employees must contact Facilities or the Office of Research Safety when a fumehood is not working properly or if the airflow monitor is in alarm.

If a chemical fume hood is required or recommended to be used, the following guidelines must be followed at all times:

- Chemical fume hoods must be marked to indicate the proper sash position for optimum hood performance. The chemical fume hood sash should be positioned at or below this height whenever working with hazardous chemicals that could generate toxic gases, vapors, fumes, aerosols or particulates.
- Most chemical fume hoods are not intended to be used with the sash fully open. The sash should only be fully opened to add or remove equipment from the chemical fume hood. Although the sash provides some splash protection employees must wear eye protection when handling hazardous chemicals within the Fumehood.
- Only apparatus and chemicals essential to the specific procedure or process should be placed in the chemical fume hood. Extraneous materials from previous experiments should be removed and stored in a safe location outside the chemical fume hood.
- Chemical fumehoods used for experimental work should not be used for chemical or equipment storage. Fumehoods used for chemical storage should only be used for storage; experimental work should not be conducted in these hoods.
- Never put your head inside of an operating chemical fume hood.

- Biological Safety Cabinets (BSC)
  A biological (or biosafety) safety cabinet is an enclosed, ventilated laboratory workspace. These units are engineered to provide protection to personnel, the product being handled on the work surface and the environment. Biological safety cabinets are primarily used for protection used for safely working with materials contaminated with (or potentially contaminated with) infectious materials. They are primarily used to provide worker protection from infectious materials and to protect materials being handled on the work surface from biological contamination. Biological safety cabinets must be certified annually in accordance with the field certification procedures detailed in NSF/ANSI 49: Biosafety Cabinetry Certification.

  The Type A2 biological safety cabinet is the most common type on campus. This type of cabinet relies on HEPA filters to remove aerosols and particulates form the air and is not

intended for use with hazardous gases or vapors. Applications that involve the use of chemicals should be conducted in chemical fume hoods.

- Laminar Flow Clean Bench
  A laminar flow clean bench is a partially enclosed bench designed to prevent contamination of the work surface. Air is drawn through a high efficiency particulate air filter and blown in a very smooth, laminar flow towards the user. It is critical that absolutely no hazardous chemicals, infectious and/or radioactive materials ever be used in a laminar flow clean bench, as the vapors are blown directly towards the user. The handling of laboratory animals on a laminar flow clean bench should also be avoided as it may increase researcher exposure to lab animal allergens.

- Other Engineering Containment Devices
  Other engineered containment devices may be used for specific applications, including pathology workstations, canopy hoods, perchloric acid hoods, and ductless hoods. Pathology workstations are specially designed for the gross examination and sectioning of pathology specimens. Some models include formaldehyde neutralizing filters; others are connected to facility exhaust systems. The Office of Research Safety shall evaluate pathology workstations annually to verify they are functioning as intended by the manufacturer. Owners of a pathology workstation shall be responsible for notifying the Office of Research Safety of the presence of pathology workstations in a specific work area. The owner shall also be responsible for changing formaldehyde neutralizing filters as specified by the manufacturer.

  Canopy hoods are specifically designed to vent non-toxic materials such as heat, steam and odors from large or bulky apparatus such as ovens, steam baths and autoclaves. The hood may be installed on a wall or suspended from the ceiling for peninsular and corner locations. Canopy hoods are connected to facility exhaust systems.

  Perchloric acid hoods are specifically designed for procedures involving perchloric acid. Perchloric acid is a strong oxidizer, which can produce corrosive, flammable, and/or explosive reaction products. The surfaces of the hood and ductwork are constructed of materials that will be stable and not react with perchloric acid to form corrosive flammable, and/or explosive compounds. Interior hood, duct, fan and stack surfaces are equipped with a water wash-down system. Perchloric acid hoods shall be prominently labeled “Perchloric Acid Hood.” The Office of Research Safety shall evaluate perchloric acid hoods annually to verify they are functioning as intended by the manufacturer.

  Ductless hoods incorporate an exhaust fan and filter(s) into the unit; filtered air is discharged directly into the room (instead of being connected to a facility exhaust system). Ductless hoods may be used for limited applications. Owners of ductless hoods must notify the Office of Research Safety of the intent to use this equipment on campus. The Office of Research Safety shall perform a hazard evaluation and analysis for each ductless hood prior to first use to verify the hood is appropriate for the intended purpose. The Office of Research Safety shall

evaluate ductless hoods annually to verify they are functioning as intended by the manufacturer.

PERSONAL PROTECTIVE EQUIPMENT

Supervisors shall assess the workplaces of their employees to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). The Laboratory Supervisor will select and have each affected employee use the types of PPE that will protect them from the hazards identified in the hazard assessment. To promote compliance with PPE requirements and to encourage enforcement Laboratory Supervisors must establish clear policies to delineate when the use of PPE is required. For example, "staff members must wear a lab coat and eye protection when working at the lab bench." The Office of Research Safety is available on request to assist with the selection or assignment of appropriate PPE.

Supervisors shall provide PPE training to employees required to use PPE. Training shall include the following:

- When PPE is necessary
- What PPE is necessary
- How to properly don, doff, adjust, and wear PPE
- Limitations of the PPE
- Proper care, maintenance, useful life and disposal of the PPE.

Such training shall be provided before employees are allowed to perform work requiring the use of PPE. Re-training is required under the following circumstances:

- Changes in the workplace render previous training obsolete
- Changes in the types of PPE to be used render previous training obsolete
- An affected employee demonstrates a lack of understanding of proper use of the PPE.

- Body Protection (e.g. lab coats)
  Each affected employee must wear protective clothing to protect the body from recognized hazards. Unprotected skin surfaces that are at risk of injury should be covered. Full length pants or a full-length skirt must be worn at all times by all individuals that are occupying the laboratory area; shorts are not permitted. Lab coats, coveralls, aprons, or protective suits are required to be worn while working on, or adjacent to, all procedures using hazardous chemicals or infectious materials at biosafety level 2 or higher.

  Lab coats must be appropriately sized for the individual and be fastened (snap buttons are recommended) to their full length. Lab coat sleeves must be of a sufficient length to prevent skin exposure while wearing gloves. Flame resistant lab coats must be worn when using pyrophoric materials or flammable liquids greater than 1 liter in volume.

Lab coats should not be worn outside of the lab unless the individual is traveling directly to an adjacent lab work area. Lab coats should not be worn in common areas such as break rooms, offices, or restrooms. Each department is responsible for providing laundry services as needed to maintain the hygiene of laboratory coats. They may not be cleaned by staff members at private residences or public laundry facilities. Alternatives to laundering lab coats include routinely purchasing new lab coats for employees to replace contaminated lab coats, hiring a professional garment laundering service, or using disposable lab coats. Departments can also choose to purchase a washer and dryer and launder their own lab coats.

- Eye and Face Protection
  Laboratory personnel must wear eye protection when handling hazardous chemicals in the lab. All eye protection equipment must be American National Standards Institute (ANSI) approved and appropriate for the work being done. Eye and face protection may not be required in the lab if the employee is sitting at a workstation or desk that is away from chemical processes (e.g., working at a desktop computer, having a lab meeting at a table not adjacent to hazardous operations).

  Face protection equipment must be used in conjunction with eye protection when potentially exposed to hazards from chemical splash, flying debris, or other exposures (e.g. UV light) that may occur in the laboratory.

- Hand/Skin Protection
  Employees must wear chemical protective clothing and/or gloves to minimize potential skin exposures to hazardous chemicals. No single glove or clothing article provides protection against all hazards. Employees should only use chemical protective clothing and gloves that are resistant to the hazardous chemicals of concern. Employees may also need gloves or protective clothing that provides puncture resistance and/or thermal protection.

  Manufacturers of protective clothing and gloves publish chemical resistance, thermal protection and puncture resistance data for their protective clothing and gloves. Chemical resistance data may include permeation, degradation and penetration information. For work with hazardous chemicals, the selected chemical protective clothing or glove should resist permeation, degradation, and penetration by the respective chemicals.

SAFETY EQUIPMENT

Safety equipment is located in work areas so that it is available to employees in the event of a hazardous agent exposure or other incident. The specific operations conducted in a work area will determine what safety equipment should be available. This equipment must be properly maintained so that it is accessible and functional when needed. Access to safety equipment must not be obstructed. Researchers are responsible for the upkeep of the safety equipment in their work area. This includes maintaining equipment in a clean and sanitary manner, replacing items

as they are used or expire, or notifying Facilities if something is not functioning properly or if a fire extinguisher has been used and needs to be replaced.

- Emergency Eyewash and Showers
  All laboratories using corrosive chemicals must have immediate access to safety showers and eye wash stations. All lab personnel must be aware of the location and know how to properly use the safety shower and eyewash stations. Laboratory employees are responsible for flushing eyewash stations on a weekly basis. This will keep the system free of sediment and prevent bacterial growth that may be hazardous to employees. This flush should be documented on the Weekly Eyewash Inspection Form. Any operational deficiencies with emergency eyewash station must be reported immediately to Facilities.

- Fire Extinguishers
  Fire extinguishers must be available in locations and in accordance with procedures detailed in campus safety policy FS5300 – Fire Prevention Plan. They must be mounted in locations that are free of clutter or obstruction in accordance with campus safety policy FS5302 – Portable Fire Extinguishers.

  All laboratory personnel should be familiar with the location, use, and classification of the extinguishers in their laboratory. Ensure that the fire extinguisher being used is appropriate for the type of material on fire before attempting to extinguish any fire. Laboratory personnel are not required to extinguish fires that occur in their work areas and should not attempt to do so unless:
  - It is a small, contained fire that can be quickly and safely extinguished (e.g., small trashcan sized fire);
  - Appropriate training has been received and the individual feels the fire can be safely extinguished; and
  - It is necessary to extinguish a fire in order to safely exit an area (e.g., fire is blocking an exit).

  If a fire occurs in the laboratory and is extinguished by lab personnel, the fire alarm must be pulled and the Fire Department must be contacted. It is common for fires to reignite so it is critical that the Fire Department be contacted even if the fire has been extinguished by an employee.

CHEMICAL MANAGEMENT

The proper management of hazardous chemicals includes procurement practices, labeling, storage, safe handling and disposal. Upon receipt chemicals should be labeled with the date they were received. Manufacturer labels or secondary labels must be maintained in accordance with the practices established in section 5.0 (Hazard Communication) of this Chemical Hygiene Plan. Practices for the safe storage and handling of hazardous chemicals is provided below.

- Procurement
  Hazardous chemicals should be procured in the smallest volume or quantity necessary to perform planned experiments. The speculative accumulation or stockpiling of hazardous chemicals is prohibited. Once received hazardous chemicals must be added to the hazardous chemical inventory maintained for each work area as detailed in section 5.2 of this Chemical Hygiene Plan.

- Standard Operating Procedures
  Laboratory supervisors shall maintain standard operating procedures (SOPs) for activities that involve the handling of hazardous chemicals. SOPs shall identify the control measures (e.g. engineering controls, work practices, PPE) used to mitigate hazards associated with that procedure. Institutional SOPs that establish handling requirements for specific classes of hazardous materials (e.g. pyrophorics) may be accessible on the Office of Research Safety website. Researchers must be trained on the SOPs that they are to follow. These SOPs should be maintained in a location that is readily accessible to the researchers performing the procedure. The Office of Research Safety recommends that researchers sign and date a copy of the SOPs after being trained in order to properly document this training.

- Chemical Storage
  Acceptable chemical storage locations may include flammable cabinets, corrosive cabinets, fumehood cabinets, secure laboratory shelves, or appropriate laboratory refrigerators or freezers. Chemical fumehoods should not be used as permanent chemical storage areas, unless designated as such. Not only does this create potentially unsafe conditions by having extraneous chemicals stored near chemical reactions and processes, excess chemical bottles in the hood may also seriously impair the ventilating capacity of the fumehood. Only chemicals being used in the process or experiment being conducted in the fumehood are allowed to be stored in the fumehood and should be removed when the process or experiment is complete.

  Chemicals should not be permanently stored on bench tops. Avoid storing any chemical containers on the floor unless those chemicals are placed in suitable secondary containment. Under no circumstance should chemical containers, or anything else, be stored in aisle ways, corridors, or in front of doors. Hazardous liquids should not be stored on shelves above eye-level unless there is a SOP detailing safe handling procedures. Chemicals must be stored at an appropriate temperature and humidity level and never be stored in direct sunlight. Always follow the chemical manufacturer's storage instructions, if provided.

  Chemicals should be stored in a manner that segregates chemicals of incompatible hazard categories. Specific guidance for the proper storage of chemicals can be found in the SDS for each chemical. If storage space is limited proper chemical segregation can be accomplished by using secondary containment to separate incompatible materials stored within the same

storage location. Generally, proper segregation can be achieved by separating chemicals into the following storage groups.

- Acids (oxidizing)
- Acids (organic)
- Bases
- Flammable materials
- Oxidizers (store away from combustible materials);
- Reactive and acutely toxic materials (stored away from all other chemicals)

Good chemical hygiene practices must be used whenever handling hazardous chemicals. This means taking the necessary steps to minimize exposure to hazardous chemicals by implementing the Hierarchy of Controls. Expectations for the handling of chemicals during specific activities must be clearly expressed to lab staff through training and the use of Standard Operating Procedures. Certain classifications of hazardous chemicals are subject to specific handling and storage precautions.

- Flammable Liquids

  Flammable liquids represent a fire risk. Flammable liquids include any liquid with a flash point no greater than 93 °C (200 °F). At a temperature above its flashpoint a flammable liquid produces enough vapors near its surface to form a flammable atmosphere. The fire risk increases with the volume of the container and the volatility of the flammable liquid being handled. The smallest-volume container capable of effectively fulfilling a particular need should be selected.

  The following guidelines for storing flammable liquids must be followed in all laboratories:
  - Containers of flammable liquids shall be kept closed except during transfer of contents.
  - The volume of flammable liquids within laboratories in non-healthcare occupancies shall be limited to only what is necessary for experiments occurring in the immediate future. Flammable liquids in excess of what is required for immediately pending experiments shall be stored in safety cans, flammable liquid cabinets and/or inside storage rooms.
  - Domestic refrigerators or freezers must never be used to store flammable liquids. Flammable liquids can only be stored in refrigerators or freezers that are designed for flammable materials (Note: most refrigerators and freezers are not intended for flammable storage).
  - Flammable liquids must be stored in well-ventilated areas free from ignition sources.
  - No more than 60 gallons (225 liters) of flammable liquids may be stored in a flammable liquid storage cabinet. No individual container in a storage cabinet may exceed 5 gallons (20 liters) in capacity.

- Corrosive Chemicals

Corrosive chemicals cause visible destruction and/or irreversible alteration of living tissue by chemical action at the site of contact. A hazardous chemical meeting one or more of the following criteria is considered “corrosive”:

- Chemical is identified as corrosive on SDS
- Chemical is identified as corrosive on container label
- Chemical has a pH ≤ 2.0 or pH ≥ 11.5

Employees should handle corrosive chemicals within a laboratory chemical hood. Employees are required to comply with the following work practices when handling corrosive chemicals:

- Employees shall not handle corrosive chemicals in work areas that do not have emergency eye wash and/or shower equipment
- The laboratory supervisor shall provide detailed instructions regarding appropriate personal protective equipment for tasks involving corrosive chemicals. Appropriate personal protective equipment for handling corrosive chemicals may include chemical resistant gloves, chemical-resistant apron, splash goggles, and face shield.
- Employees shall store corrosive chemicals in designated cabinets or on shelves located below eye level.
- Employees shall keep container sizes and quantities on hand as small as possible.
- When employees transport corrosive chemicals between laboratories, such chemicals shall be secured to a movable cart and/or contained within packaging that meets shipping requirements of the IATA Dangerous Goods Regulations.

- Peroxide-Forming Chemicals

  Peroxide-formers are a class of highly-volatile, flammable, organic solvents which can form dangerous levels of peroxides. Examples of common laboratory reagents that fall into the category of peroxide-forming chemicals include diethyl ether, tetrahydrofuran, dioxanes and benzyl alcohol. The peroxides formed are sensitive to shock and friction and can cause dangerous reactions. As a result, this class of compounds have a shelf-life while in storage. Chemical containers with contents that have crystallized, have been tested and found to contain a peroxide concentration above 30 ppm, or that have been stored past their expiration date may incur additional precautions facilitate their disposal. Containers believed to have become reactive may require the temporary shutdown of the laboratory where the chemicals are contained and other laboratories located adjacent to the route of disposal. This can be both an expensive and time-consuming process.

  Laboratory personnel should purchase the smallest amount needed for an upcoming experiment. This will minimize quantities kept on site. Peroxide-formers should be purchased in an inhibited state. New containers of peroxide-formers should be checked for integrity and possible loss of contents.

Laboratory personnel must follow the chemical manufacturer's recommendations for the storage of these compounds. Peroxide-formers should be stored in a manner that minimizes exposure to air, light, heat, vibration, and shock. The container must be closed at all times when not in use. They must also observe the chemical manufacturer's expiration date. (In most cases this expiration date is less than 24 months from the date of purchase.) Peroxide-forming chemicals must be dated when received from the chemical manufacturer and dated again when the container is opened.

Before opening containers of peroxide-forming chemicals laboratory personnel must inspect the container and its contents. If the contents appear to have evaporated, crystals have developed, the material is discolored, or if the container has been damaged the container must not be used and the Office of Research Safety must be contacted at ext. 8-6114 to make arrangements for disposal.

Peroxide test strips must be available in laboratories where peroxide-forming chemicals are handled or stored. Laboratory personnel should test the peroxide concentration each time the container is opened. If the test strip [which test up to concentrations of 100 peroxide parts per million(ppm)] indicates that the peroxide concentration is greater than 30 ppm, the substance shall be re-stabilized and inhibited or the Office of Research Safety shall be notified for disposal arrangements.

- Perchloric Acid
  The handling of perchloric acid is particularly dangerous and should not be performed in any fumehood except those specially designed for perchloric acid use. Perchloric acid is a highly reactive material when in contact with incompatibles. It can explode on contact with many organics and can form potentially explosive metal perchlorates through contact with metals. It is also forbidden from transport in concentrations >72%. Perchloric acid should be stored and used in glass or other inert, and preferably unbreakable, containers.

- Carcinogens, Reproductive Hazards and Acutely Toxic Chemicals
  Carcinogens include, but are not limited to, chemicals that meet one or more of the following criteria:

  - Regulated by OSHA as a carcinogen
  - Listed in the National Toxicology Program Annual Report on Carcinogens as a known human carcinogen or reasonably anticipated to be a human carcinogen
  - Listed by the International Agency for Research on Cancer as a human carcinogen, probable human carcinogen, or possible human carcinogen
  - Listed by the National Institute for Occupational Safety and Health (NIOSH) as a potential occupational carcinogen
  - Listed on the manufacturer's SDS as a human carcinogen or possible human carcinogen.

Reproductive hazards include chemicals that may affect the reproductive health of women or men or the ability of couples to have healthy children. Reproductive hazards may cause problems such as infertility, miscarriage, and birth defects.

Acutely toxic chemicals include those defined as toxic under the TOSHA Hazard Communication Standard and may be fatal or cause damage to target organs as a result of a single exposure or exposures of short duration. TOSHA defines a toxic chemical as one that meets one of the following characteristics:

- Has a median lethal dose (LD50) of not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- Has a median lethal dose (LD50) of not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours with the bare skin of albino rabbits weighing between two and three kilograms each.
- Has a median lethal concentration (LC50) in air of not more than 2,000 parts per million by volume of gas or vapor, or not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour to albino rats weighing between 200 and 300 grams each.

Supervisors and their employees shall consider special provisions when handling carcinogens, reproductive hazards or acutely toxic chemicals. Whenever possible these materials should be handled within a chemical fumehood or other engineered enclosure. Additional provisions include the establishment of designated areas, use of appropriate personal protective equipment, decontamination procedures, and procedures for safe removal of contaminated waste.
Laboratory supervisors should consider establishing Designated Areas for the safe storage and handling of select carcinogens, reproductive hazards and acutely toxic chemicals. Supervisors should evaluate the need to establish a designated area based on the toxicity of the compound(s) being handled, the potential for personnel exposure, and potential for residual contamination. A fumehood, a section of a laboratory or an entire laboratory may be delineated as a Designated Area. When delineating a Designated Area, the area shall be marked with a sign or label with the following language “Caution - Designated Work Area - Select carcinogens, reproductive hazards, or substances of high acute toxicity may be present.”

Employees must regularly clean work areas used for carcinogens, reproductive hazards and acutely toxic chemicals. These areas must be cleaned with a suitable decontaminant. Refer to the SDS for decontamination procedures for specific chemical reagents. Supervisors and employees should be advised that hazardous drugs (e.g. antineoplastic agents, antiviral medications, tamoxifen, BrdU, cyclophosphamide, etc.) may not be suitably decontaminated

with alcohol. A 1-10% bleach solutions is the required surface decontaminant for many hazardous drugs.

Empty containers used to hold carcinogens, reproductive hazards or acutely toxic materials can be discarded as conventional trash unless the contents were specifically identified by the EPA as U or P listed hazardous waste. In such situations the container itself must be discarded as hazardous waste or triple rinsed with a suitable solvent before being discarded. In such situations that rinsate must be discarded as hazardous waste. Materials used to clean spills of carcinogens, reproductive hazards or acutely toxic chemicals must be placed in an appropriate, sealable container, and discarded as hazardous waste.

COMPRESSED GASES

Compressed gases are defined as gases that are contained in a receptacle at a pressure not less than 280 kPA at 20 °C or as a refrigerated liquid. The following general guidelines for storing compressed gases must be followed for all compressed gases and in all laboratories. Refer to UTHSC policy HM5200 Compressed Gas Safety for detailed requirements for the handling and storage of specific compressed gases.

- Cylinders that are in use, meaning there is a regulator attached, must be individually secured by a chain or strap to a fixed building structure or component.
- Cylinders that are not in use must be stored with the valve cap on and secured to protect the valve.
- The regulator must be replaced with a safety cap when the cylinder is not in use.
- The safety cap must be in place when a gas cylinder is moved. For large gas cylinders (>27 inches), an approved gas cylinder cart should be used to move it.
- Compressed gas cylinders (cylinders) must be stored in a secure, well ventilated location, and in an upright position. Small cylinders such as lecture bottles are not required to be stored in the upright position; they can be safely laid down in a chemical cabinet. However, when lecture bottles are in use they should be secured and stored in an upright position if possible.
- All cylinders should be handled as if full and should never be completely emptied.
- Multiple cylinders may only be secured together if they are capped (not in use) and of compatible hazard class. Only capped cylinders can be secured with a single restraining device.

CHEMICAL WASTE

Hazardous waste is generally defined as waste that is dangerous or potentially harmful to human health or the environment. Hazardous waste regulations are strictly enforced by both the Environmental Protection Agency (EPA) and the Tennessee Department of Environmental Conservation. The Laboratory Supervisor is responsible for managing the hazardous waste

program in a safe and compliant manner. No chemical waste should be poured down the drain or discarded in the trash without specific approval of the Office of Research Safety.

Hazardous waste falls into one of the following categories:

- Characteristic Wastes are wastes that exhibit one or more of the following properties:
    - Ignitable,
    - Corrosive,
    - Reactive, or
    - Toxic
- Listed Wastes are wastes from common manufacturing and industrial processes (F-listed), wastes from specific industries (K-listed), and wastes from commercial chemical products (U- and P-listed). Examples of U- and P- listed wastes sometimes handled in laboratories include cyclophosphamide, warfarin, epinephrine streptozotocin and other hazardous drugs. Empty containers of U- and P- listed materials must be handled as hazardous waste unless triple rinsed with a suitable solvent to remove any chemical residue. Rinsate used to clean waste containers must itself be discarded as hazardous waste.
- Universal Waste includes certain batteries (primarily rechargeable batteries such lithium, nickel-cadmium, nickel metal hydride, and mercury oxide), mercury-containing equipment (e.g., thermometers, thermostats), and certain lamps (e.g., fluorescent bulbs). Note: alkaline batteries and incandescent bulbs are not considered Universal Wastes and can be legally disposed of as trash.
- Mixed Waste consists of hazardous chemical waste mixed with radioactive waste.

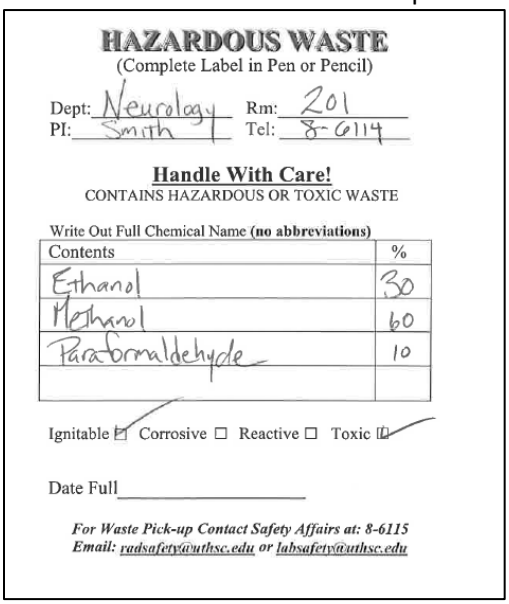
EPA-regulated hazardous waste should not be mistaken for biological or radiological wastes.

- Waste Determinations
  All chemical constituents in a hazardous waste container must be identified by knowledgeable laboratory personnel. Not only is this required by the EPA, it also ensures that waste can be properly characterized and disposed of by the Office of Research Safety or Campus Safety. If there is uncertainty about the composition of a waste stream resulting from an experimental process, laboratory employees must consult the Laboratory Supervisor for assistance or the Office of Research Safety for assistance. In most cases, careful documentation and review of the SDS for all chemical products used in the experimental protocol will result in accurate waste stream characterization. Information contained within an SDS pertinent to making a hazardous waste determination can be found in specifically Section 2, “Hazard Identification” and Section 13, “Disposal Considerations.” If the composition of a waste is unknown and cannot be determined the Office of Research Safety may perform additional analysis on this material.

- Hazardous Waste Labeling
  All waste must be properly labeled as soon the first drop of waste enters a waste container. Containers must be labeled and clearly marked with the words "Waste" or “Hazardous

Waste" and list the chemical components of that waste. Hazardous waste labels are available on the Office of Research Safety website. These labels should be filled out in a percentage format as shown below. Listing accurate percentages is not as important (+ 5% is acceptable and constituents less than 1% can be listed as "trace") as listing all of the chemicals that makeup the waste. If a chemical is found in the laboratory and the composition is unknown, it should be assumed to be hazardous and labeled as "Hazardous Waste – awaiting proper characterization".

Hazardous Waste Label Example



HAZARDOUS WASTE
(Complete Label in Pen or Pencil)

Dept: Neurology Rm: 201
PI: Smith Tel: 8-6114

Handle With Care!
CONTAINS HAZARDOUS OR TOXIC WASTE

Write Out Full Chemical Name **(no abbreviations)**

Contents	%
Ethanol	30
Methanol	60
Paraformaldehyde	10

Ignitable ☑ Corrosive ☐ Reactive ☐ Toxic ☑

Date Full _____

For Waste Pick-up Contact Safety Affairs at: 8-6115
Email: radsafety@uthsc.edu or labsafety@uthsc.edu

- Waste Storage
  Hazardous waste containers in UTHSC laboratories are stored in satellite accumulation areas (SAA). SAAs are used to manage hazardous waste in laboratories and shops because doing so provides safe and effective means to accumulate hazardous waste before removal by Campus Safety. Additionally, SAAs provide the least restrictive regulatory option for the accumulation and storage of hazardous waste containers. The following SAA rules must be followed at all times when managing hazardous waste in a laboratory:

  - All waste must be stored in containers.
  - Containers must be in good condition and compatible with the waste they contain (no corrosive waste in metal containers).
  - Containers must be kept closed at all times except when adding or removing waste.
  - Containers must be properly labeled.
  - Containers must be stored at or near the point of generation and under the control of the generator of the waste (wastes should remain in the same room they were generated in). A central waste collection room should not be established.
  - The waste storage volume should never exceed 55 gallons per SAA.

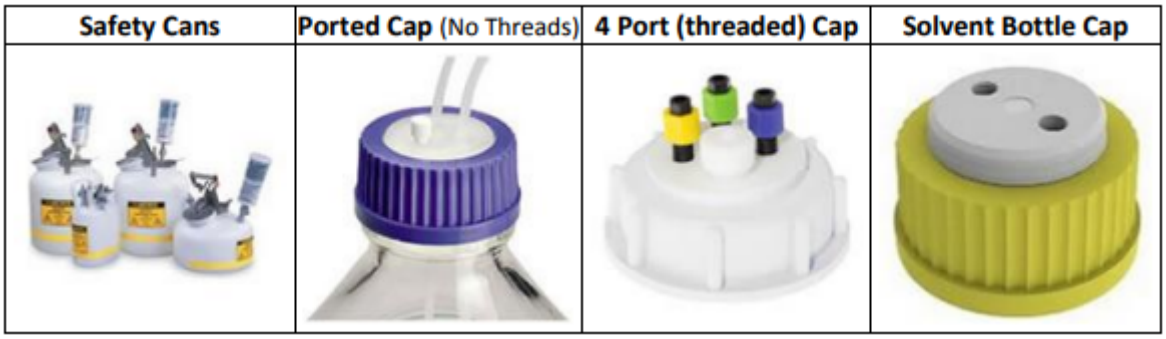
- Containers should be segregated by chemical compatibility during storage (e.g., acids away from bases, secondary containment can be used as a means of segregation).
- Avoid halogenated and non-halogenated wastes in the same waste container.
- Avoid mixing incompatible waste streams in the same container (e.g., acids with bases, oxidizers with organic solvents) that will potentially create an exothermic reaction in the waste container.
- Collect all highly toxic, reactive, mercury and any exotic wastes (e.g., dioxin compounds, PCBs, controlled substances) separately even if they are chemically compatible with other waste streams. Failing to do so can result in costly disposal fees (e.g., mixing mercury with an organic solvent waste means that the entire waste stream must be treated as mercury waste).
- All spills and leaks must be cleaned up immediately. Spill clean-up waste must be bagged and discarded as hazardous chemical waste.

- Waste Disposal Procedure
  Campus Safety provides pickup services for all chemical waste generated on the UTHSC campus. Requests a hazardous waste pickup by emailing labsafety@uthsc.edu and identifying the building and room number where the waste is located, the type of waste (e.g. methanol and stains), and the number of containers. Average turnaround time is 1-2 business days.

- Liquid Chromatography Waste
  Liquid chromatography (LC) is an analytical technique used to separate, identify, quantify, and purify individual components of a mixture. This technique is very common in biological and chemical research. The most common type of LC at UTHSC is High Performance Liquid Chromatography (HPLC). UTHSC has numerous LC instruments located in campus laboratories. Since organic solvents (e.g., methanol, acetonitrile) are commonly used in the process, most LC waste is regulated by the EPA as hazardous waste. Consequently, all containers collecting LC waste be properly labeled and acceptable to place a waste line running from the LC unit into an open waste container nor is it acceptable to use foil or Parafilm® as a means of closure must remain closed while the LC unit is in operation. It is neither acceptable to place a waste line running from the LC unit into an open waste container nor is it acceptable to use foil or Parafilm® as a means of closure.

Figure 11..5a - Improper LC Waste Collection Processes

Figure 11.5b - Proper LC Waste Collection Processes



- Sharps Waste
  Sharps are items capable of puncturing, cutting, or abrading the skin such as syringes, razor blades, scalpels, glass or plastic pipettes or broken glass. Sharps waste must be discarded in an FDA-approved sharps container labeled with the biohazard symbol. Refer to the Campus Safety Regulated Medical Waste Policy (HM5201) for additional information about the handling of infectious sharps and regulated medical waste.

  Clean uncontaminated broken glassware and plastic sharps should be placed in a broken glass box (available from General Stores in the GEB) equipmed with a plastic garbage liner. Do not exceed 20 pounds. When ready for disposal, the box must be taped shut and prominently labeled as “Sharp Objects/Glass – Discard” or similar wording. Contact your Housekeeping supervisor of submit a Facilities request using the Archibus system to have the glass picked up.

HOUSEKEEPING

Housekeeping is a required element of the UTHSC laboratory safety program. A clean, well-maintained lab improves safety by preventing accidents and can enhance the overall efficiency of the work being performed. Observe the following laboratory housekeeping guidelines:

- Doorways and hallways must be free of obstructions to allow clear visibility and exit.
- The laboratory should be uncluttered without excessive storage of materials that could cause or support a fire (e.g., paper, cardboard, flammable liquids, etc.).
- Fire protection sprinklers must be unobstructed; a minimum of 18 inches of clearance is required below the sprinkler head.
- Do not store items that block fire extinguishers or eyewash and safety shower stations.
- Do not store items in front of electrical boxes/panels in the lab.
- A routine cleaning schedule should be established. All work surfaces should be kept as clean as possible. All potentially chemically contaminated work area surfaces (e.g., chemical fume hood deck, countertops) should be cleaned routinely (e.g. daily, weekly).
- For operations where spills and contamination are likely (e.g., agarose gel electrophoresis/ethidium bromide applications), cover work spaces with a bench paper or liner. The soiled bench paper should be changed on a routine basis or as needed.
- All chemical spills must be cleaned up immediately.
- Do not allow materials to accumulate in lab fumehoods and remove used tissues, foil, gloves, or other unnecessary objects immediately after use.
- Ensure that all waste (e.g., trash, chemically contaminated debris waste, etc.) is placed in the appropriate containers. Do not overfill waste containers.
- All equipment should be cleaned and returned to storage after each use.
- Equipment should be stored in a safe and orderly manner that prevents it from falling.
- Chemical containers must be clean, properly labeled, and returned to storage upon completion or usage.
- Avoid storing liquids above eye level.
- Do not store heavy or frequently used items on top shelves. Locate items used daily close to the work area.

EXPOSURE ASSESSMENT

Employees' airborne exposures to hazardous chemicals shall be below limits set by TOSHA (Tennessee Occupational Safety and Health Administration), ACGIH (American Conference of Governmental Industrial Hygienists), NIOSH (National Institute for Occupational Safety and Health), and/or AIHA (American Industrial Hygiene Association). Employees shall use engineering controls and work practices to minimize exposures to airborne hazardous chemicals. Where engineering controls and work practices are not sufficient to maintain exposures below exposure limits, employees shall use respiratory protection to reduce exposures below such limits.

- Occupational Exposure Limits
  TOSHA maintains the following types of exposure limits:

- **Permissible Exposure Limit (PEL)** – The PEL is an 8-hour time-weighted average exposure limit during a 40-hour work week, which shall not be exceeded.
- **Short Term Exposure Limit (STEL)** – The STEL is a 15-mintue time-weighted average exposure limit, which shall not be exceeded during the work day.
- **Ceiling Limit** – The Ceiling Limit is an instantaneous exposure limit, which shall not be exceeded.

ACGIH maintains the following types of exposure limits:

- **Threshold Limit Value-Time-Weighted Average (TLV-TWA)** – The TLV-TWA is a time-weighted average concentration for a conventional 8-hour work day during a 40hour work week, to which it is believed that nearly all workers may be repeatedly exposed, day after day, for a working lifetime, without adverse effect.
- **Threshold Limit Value-Short Term Exposure Limit (TLV-STEL)** – The TLV-STEL is a 15-minute time-weighted average exposure that should not be exceeded at any time during the work day. The TLV-STEL is the concentration to which it is believed that workers can be exposed continuously for a short period of time without suffering from (1) irritation, (2) chronic or irreversible tissue damage, (3) dose-rate dependent toxic effects, or (4) narcosis of sufficient degree to increase the likelihood of accidental injury, impaired self-rescue, or materially reduced work efficiency.
- **Threshold Limit Value-Ceiling (TLV-C)** – The TLV-C is the concentration that should not be exceeded during any part of the working exposure.

NIOSH maintains the following types of exposure limits:

- **Recommended Exposure Limit (REL)** - The REL is a 10-hour time-weighted average exposure limit during a 40-hour work week, which should not be exceeded.
- **Short Term Exposure Limit (STEL)** – The STEL is a 15-mintue time-weighted average exposure limit, which should not be exceeded during the work day.
- **Ceiling Limit** – The Ceiling Limit is an instantaneous exposure limit, which should not be exceeded.

AIHA maintains the following types of exposure limits:

- **Workplace Environmental Exposure Level – Time Weighted Average (WEEL-TWA)** – The WEEL-TWA is an 8-hour time-weighted average exposure limit during a 40-hour work week, which should not be exceeded.
- **Workplace Environmental Exposure Level - Short Term Exposure Limit (WEEL-STEL)** – The WEEL-STEL is a 15-mintue time-weighted average exposure limit, which should not be exceeded during the work day.
- **Workplace Environmental Exposure Level - Ceiling Limit (WEEL-Ceiling Limit)** – The WEEL Ceiling Limit is an instantaneous exposure limit, which should not be exceeded.

TOSHA standards are enforceable by law. ACGIH, NIOSH and AIHA exposure limits are consensus standards and not enforceable by law.

UTHSC generally uses the most stringent standard(s) for each hazardous chemical from TOSHA, ACGIH, NIOSH or AIHA as our institutional standard(s). Occupational exposure limits

for specific chemical compounds can be found online in the NIOSH Pocket Guide to Chemical Hazards.

- Occupational Exposure Assessments
  The Director of Research Safety manages the occupational exposure assessment program. Exposures are categorized based on the following criteria:

  - Nature of job task
  - Quantity of hazardous chemical(s) handled
  - Frequency of task
  - Hazards associated with the chemical(s)
  - Exposure limits for hazardous chemical(s)
  - Exposure assessment data

  Based on the categorization and assessment, exposures associated with specific job tasks are determined to be below or above exposure limits. Employees or supervisors may request an occupational exposure assessment by contacting the Office of Research Safety.

  Periodic exposure monitoring is not necessary for those exposures, which are determined to be highly controlled (i.e., exposure less than 10% of the occupational exposure limit). Other exposures will be evaluated at a frequency to be determined by the Director of Research Safety, the affected employees, and supervisor of such employees.

- Recordkeeping
  The Office of Research Safety maintains copies of exposure assessment reports. Copies of exposure assessment reports are also distributed to the employee, his/her supervisor, and the Occupational Health Office. Exposure assessment reports are filed in the employee's medical record.

INFORMATION AND TRAINING

Effective training is crucial to a successful laboratory safety program. It is the responsibility of Laboratory Supervisors to actively participate in the training process to ensure that all lab employees are effectively trained before any work with hazardous materials occurs. The Office or Research Safety assists with this process by providing safety training on a variety of topics. However, training provided by the Office of Research Safety does not comprehensively address the hazards associated with specific experimental protocols or work areas.

Supervisors shall provide job-specific chemical safety training to employees. Such training shall include a discussion of the specific physical and health hazards of chemicals in their work areas. Such training shall be provided at the time of their initial assignment, whenever a new hazard is introduced into their work area and at least annually.

- Laboratory Safety and Chemical Hygiene

All laboratory employees (graduate students, lab technicians/managers, post-docs, visiting scientists, etc.) shall participate in annual Laboratory Safety and Chemical Hygiene training. Such training is offered by the Office of Research Safety as an in-person class or as a computer-based course provided through the UTHSC K@Te portal and accessible through the Office of Research Safety training website. New employee and students working in labs are strongly advised to attend in-person training.

The annual Laboratory Safety and Chemical Hygiene training program covers the following topics:

- The contents of this Chemical Hygiene Plan
- TOSHA requirements
- Hazard communication
- Detection of hazardous chemicals in work areas
- Exposure assessments
- Safe work practices
- Engineering controls
- Personal protective equipment
- Standard Operating Procedures
- Medical consultation
- Hazardous wastes
- Chemical spill response

- Work Area Specific Training
  Laboratory supervisors shall provide work area specific training to ensure that employees are adequately informed about the hazards and procedures associated with the activities they are required to perform within their work area. This include completing the hazard communication training for specific chemical hazards, SOPs, proper use PPE, engineering controls and other potential hazards located in their work area. The general format for safety training to be provided along with each work activity is as follows:

  - Identifying the hazards
  - Signs or symptoms of exposure
  - Mitigating the hazard (engineering controls, administrative controls, PPE)
  - How to respond in the event of exposure

- Documentation
  Supervisors shall keep records of job-specific chemical safety training provided to employees. Such records shall include employee names, dates of training, and brief descriptions of the training. The Office of Research Safety shall maintain a record of training provided online or through classes offered through that office.

EMERGENCY PROCEDURES FOR ACCIDENTS AND SPILLS

Chemical spills in the laboratory can pose a significant risk to human health and the environment. All lab personnel must be trained on how to properly respond to chemical spills in order to minimize risk. In general, chemical spills can be placed into one of two categories: nonemergency chemical spills, or emergency chemical spills.

- Non-Emergency Chemical Spill Procedures
  Non-emergency chemical spills are generally defined as spills involving a material, a quantity and in a location that the employee has been trained to handle. For example, a small spill of a routinely handled chemical reagent on a fumehood benchtop.) These spills can be cleaned up by properly trained lab personnel using conventional lab PPE (e.g., safety glasses/goggles, lab coat, gloves) and a lab spill kit. In general, when a non-emergency spill occurs in the lab the area around the spill should be isolated, everyone in the lab should be made aware of the spill, and the spilled material should be absorbed and collected using either pads or some other absorbent material such as oil dry or kitty litter. Decontamination of the spill area should be conducted using an appropriate solvent (soap and water is often the most effective). Proper PPE should be worn at all times and only trained personnel should conduct the cleanup after reviewing the SDS(s) (specifically Section 6, “Accidental Release Measures”) to obtain chemical-specific cleanup information.

- Emergency Chemical Spill Procedures
  Emergency chemical spills are spills of any hazardous material in a quantity or location that the employee has not been trained to handle. These spills are generally more than a liter in volume and involve a highly toxic or reactive compound, present an immediate fire or environmental hazard, or require additional PPE (e.g., respirator) and specialized training to properly cleanup. The following procedures should be followed in the event of an emergency chemical spill:
  - Cease all activities and immediately evacuate the affected area (make sure that all personnel in the area are aware of the spill and also evacuate).
  - If chemical exposure has occurred to the skin or eyes, the affected personnel should be taken to the nearest safety shower and eyewash station.
  - Dial 8-4444, which will contact the UTHSC Police Department (UTHSC PD). The UTHSC PD will contact the Office of Research Safety to initiate an emergency chemical spill response and clean-up. If the situation is, or could become an emergency (e.g., chemical exposure has occurred, a fire or explosion has occurred) the UTHSC PD will be able to contact the appropriate authorities (e.g. fire department, administration, etc.) Be prepared to provide the following information:
    - Name of person reporting
    - Any injuries or exposures
    - The location of the spill (building and room number).
    - The type of material(s) and approximate volume spilled.
    - Control measures already implemented.

- Control access to the spill location until the spill response team arrives. This can be done by closing doors, posting signs or otherwise preventing personnel from entering the vicinity of the spill or areas where toxic vapors may be present.

- Chemical Spill Kits
  Each laboratory should have a spill response kit available for use. Lab spill kits can either be purchased from a vendor or created by lab personnel, but each spill kit should be equipped to handle small spills of the most common hazards in the laboratory. Spill response and cleanup materials that should be in the kit include:
  - Absorbent materials such as pads, booms, oil dry or kitty litter.
  - Neutralizing agents (e.g., Spill X) for acids and/or bases if high volume of acids and/or bases are stored in the laboratory.
  - Containers such as drums, buckets, and/or bags to containerize spilled material and contaminate debris generated during the cleanup process.
  - PPE such as gloves, safety glasses and/or goggles, lab coat or apron, chemical-resistant booties.
  - Caution tape or some other means to warn people of the spill.

EXPOSURE RESPONSE

Employees shall be informed how to respond to exposures as part of the hazard communication training associated with the specific hazards that they encounter in their work area. This shall include first aid information such as that provided in the first aid section of a SDS. Incidents must also be reported in accordance with the procedure detailed in Office of Research Safety policy RS-102: Incident Reporting.

Accidents/injuries and hazardous agent exposures must be reported to a supervisor immediately.

- In a medical emergency that is life-threatening or results in serious bodily injury, employees must call 911 or go to the nearest hospital emergency room. The employee's supervisor or a family member should call the CorVel 24-hour nurse line at 1-866-245-8588 to report the incident.
- For non-emergency injuries, employees and their supervisor must call the CorVel 24-hour nurse line at 1-866-245-8588. A nurse will determine if your injury will require self-care, or urgent care and provide you with the nearest authorized medical provider.
  - If the injury only requires self-care, this would be an incident only claim and no further action would be needed with CorVel.
  - When medical treatment is needed, supervisors must make a follow-up phone call to CorVel. Failure of the supervisor to call CorVel and complete the First Notice of Loss will result in the department being fined by the State.
  - On the University of Tennessee Risk Management website, there are links to the "Incident Report," "Lost Time/Return to Work Calendar," and "Employee and Supervisor Instructions" forms. When warranted by the nature of the incident or injury completed

by employee's and their supervisor. Once completed, form must be forwarded to your campus HR/WC representative.

- Every attempt must be made to report the incident within 48-hours of becoming aware of the incident.
- Concerns related to health, safety and compliance in research may be reported by contacting the Office of Research Safety at 448-6114 or emailing labsafety@uthsc.edu.

MEDICAL CONSULTATION

Employees must notify their Laboratory Supervisor of all injuries and illnesses regardless of the magnitude. If the injury is serious and presents an emergency situation, dial 8-4444 and emergency. In a medical emergency that is life-threatening or results in serious bodily injury, employees must call 911 or go to the nearest hospital emergency room. The employee's supervisor or a family member must call the CorVel 24-hour nurse line at 1-866-245-8588 to report the incident.

For non-emergency injuries, employees and their supervisor must call the CorVel 24-hour nurse line at 1-866-245-8588. A nurse will determine if your injury will require self-care, or urgent care and provide you with the nearest authorized medical provider. If the injury only requires self-care, this would be an incident only claim and no further action would be needed with CorVel. When medical treatment is needed, supervisors must make a follow-up phone call to CorVel within 48 hours of the incident. Failure of the supervisor to call CorVel s will result in the department being fined by the State.

Employees, who work with hazardous chemicals, have an opportunity to receive medical consultations and/or examinations from the Occupational Health Office under the following circumstances:

- Exposures that cause an employee to experience signs or symptoms associated with a hazardous chemical.
- Airborne exposures to hazardous chemicals that exceed occupational exposure limits
- Exposures resulting from a spill, leak, explosion, or other occurrence.

Medical consultations and examinations are performed by or under the direct supervision of a licensed healthcare practitioner.

APPENDIX A
LABORATORY HAZARD ASSESSMENT

Laboratory Use: _____
(Type of Work)
Building: _____ Room(s): _____

POTENTIAL HAZARDS

____ Shock/Heat Sensitive Chemicals
____ Water Reactive Chemicals
____ Flammable Chemicals
____ Pyrophoric Chemicals
____ Corrosive Chemicals
____ Carcinogens or Reproductive Hazards
____ Other(s) _____

_____ Biohazards (BSL _____)
_____ Lasers (Class 3B or 4)
_____ Cryogenic Liquids
_____ High pressure equipment
_____ Compressed Gas Cylinders
_____ ≥400 Volt Power

Protective equipment required: _____

_____

This document shall serve as certification of a workplace hazard assessment. Individuals working in this area will be trained on the use, maintenance and limitations of personal protective equipment and engineering controls.

Principal investigator
or Laboratory Supervisor: _____ Phone: _____

Personnel to be Notified in Case of Problems:

Name	Phone
_____	_____
_____	_____
_____	_____

Date of Last Inspection: _____

APPENDIX B
LABORATORY FUMEHOOD EVALUATION PROCEDURE

Hood Manufacturer:_____

Hood Model Number:_____

Hood Type:_____

Hood Owner:_____

Hood Location:_____

Hood Identification: _____

Date of Performance Evaluation: _____

Due Date for Re-Evaluation: _____

Report Number: _____

Performance Evaluator:

University of Tennessee Health Science Center
Office of Research Safety
901-448-7374

1. **Face Velocity Test:** Face velocity measurements shall be made by dividing the hood opening into equal area grids. Each grid shall represent a 12" by 12" test point for the VelGrid. Velocity measurements shall be made at multiple, overlapping locations until the entire hood opening is tested. The VelGrid shall not be placed within 1" of the sides, bottom or sash of the hood opening. An anemometer may be used as an alternative to the VelGrid. Anemometer measurements shall be collected at the center of each 12" by 12" test square.

Measurement instrument:_____

Instrument calibration date: _____

Sash configuration: _____

Sash operating height: _____

Hood opening area (at sash operating height): _____

Grid spacing: _____

Face velocity measurements: _____

Average face velocity (fpm): _____

Damper or exhaust fan adjustments: _____

Acceptance criteria: The average face velocity shall be 80 to 120 fpm. No single grid velocity shall be less than 60 fpm or greater than 150 fpm.

Face Velocity Test: Pass / Fail

2. **Airflow Visualization Test:** Smoke shall be generated 6" into the hood along the opening perimeter and the horizontal center line of the opening.

Measurement instrument: _____

Test results: _____

Acceptance criteria: Visible smoke escape beyond the plane of the sash when generated

6" into the hood shall constitute a failure.

Airflow Visualization test: Pass / Fail

3. **Airflow Alarm Assessment Tests:** Test the audible and visual airflow alarm signals by engaging the test button on the alarm panel. If the alarm panel has a face velocity display, record the velocity.

Audible and visual airflow alarm operation: _____

Face velocity display value: _____

Acceptance criteria for airflow alarms: Upon activation of the test button, the airflow alarm shall indicate a visual and audible alarm. The face velocity display value shall be within 10% of the measured average face velocity.

Airflow Alarm Assessment Tests: Pass / Fail

Final Assessment

Check one:

□ This laboratory chemical hood **passed** all of the above performance evaluation tests.

□ This laboratory chemical hood **failed** one or more of the above performance evaluation tests.

Comments:

_____

_____

_____

_____